the Inventor of it. His Words are theſe,—" Supra " hoc Microſcopium Catillum ferruminavi, ut oculus " objecta tanto melius videret: nam cuprum circa " Microſcopium, quantum pote, lima abraſeram, ut " Lumen in conſpicienda objecta, quantum pote, " irradiaret."

See the Figure of this Apparatus in TAB. IV. *at* G.

X. *An Inquiry into the Cauſes of a* dry *and* wet Summer. *By an* anonymous *Hand.*

THE wet Weather which we had in *March* 1734. (the Year beginning with *January*) ſet me on conſidering what might be the Cauſes of it. The Wind was then, generally, South-weſt, the Weather rainy. Sometimes it veered to South-eaſt, which, commonly, brought much Rain: But the Wind ſeldom ſtood at that Point 24 Hours, before it returned to South-weſt again. A ſtrong Gale at South-weſt, with Rain, would be ſucceeded by as ſtrong at North-weſt, ſtill raining; but if the North-weſt continued 24 Hours, it cleared the Sky. The Summer following was cold and wet; the Wind on the ſame Points. The preceding Winter was mild, and eſpecially *December*, in which Month, from the 10th incluſive, the Wind blew, generally, South-weſt, ſometimes ſtrong, attended with much Rain. At the End of *December*, the Birds ſang, and the Graſs did grow as at other Years in the Spring.

The Winter of 1734. was as mild as that of 1733. the Birds as joyful, and the Graſs as green at the End of

of *December*, the ſame Winds ſtill prevailing; but the South-weſt was more ſtormy. On *December* 29th, there blew a Storm, firſt from South-weſt, and then from North-weſt: But the Storm of *January* the 8th was much ſtronger, which blew on the ſame Points. The Summer of 1735. was colder, and wetter than the preceding Summer.

This put me on recollecting what ſort of Winter went before a dry Summer. In the Year 1731. the Summer was remarkably dry. I had not begun to keep a Journal of the Weather in the Year 1730. But I took ſo much Notice of the unuſual Cold in *April* 1731. that I made the following Remarks. *April* 1. begins with peircing cold Winds at North-eaſt, black Clouds, ſtormy, very dry. 4th, 5th, ſome Wind, Ice. 6th, 7th, 8th, 9th, ſame Wind. 9th, Snow. 10th, The Harbour frozen over. If my Memory doth not fail me very much, it was in the Winter of the Year 1730. or the Beginning of 1731. that a *Horſe* was frozen to Death in *Moſcow*, as he ſtood in the Street.

From hence I conclude, that a froſty Winter produces a dry Summer; and a mild Winter a wet Summer. I am ſenſible, that theſe Concluſions are drawn from ſhort and imperfect Obſervations: But, ſuppoſing them to be true, I would be glad to know why theſe things are ſo.

I find from theſe and ſome other Obſervations, which I have caſually made, that the Weather depends very much on the Wind. I ſhall therefore begin with inquiring what is the Cauſe of Winds, and then proceed to find out, as well as I can, why the Wind doth influence the Weather.

Wind

Wind is a Stream of Air; Air an unmixed Fluid encompaſſing our Globe, with a Shell of at leaſt 60 Miles thick. Every Particle of Air gravitates equally towards the Centre of the Earth. Air is capable of being compreſſed and expanded: The more Air is compreſſed, the heavier it is; the more it is expanded, the lighter. Cold and Heat, whatever they be, or however they act, produce theſe contrary Effects in the Air: That is, Cold doth compreſs the Air, and Heat expands it: Therefore Cold and Heat, in different Parts of the Air, will make it flow: For Cold making the Air heavy, and Heat making it light, the lighter muſt, of courſe, give Way to the heavier; as, in a Balance, a greater Weight makes a ſmaller riſe. We daily ſee a Proof of this in a Stove.

The Sea and Land-breezes, and the Trade-wind, owe their Original to theſe Cauſes. The Sea-breeze, when regular, begins at Nine o'Clock in the Morning, approaches the Shore gently, at firſt; increaſes till Twelve; retains its full Strength till Three; then gradually decreaſes till Five, when it dies away. At Six in the Evening the Land-breeze begins, and continues till Eight next Morning: The Interval between theſe Two Breezes, at Morning and Evening, are the hotteſt Parts of the Day. It is ſaid, that theſe Winds vary in their Periods; which not being to my Purpoſe, I take no Notice of.

The way of accounting for this Viciſſitude of Sea and Land-wind, is thus: The Sun, as it aſcends, ſheds its Heat equally on the Land and Sea; but the Earth receives the Heat ſooner than the Water, or elſe reflects it ſtronger. For one or both of theſe Reaſons, the Air that hangs over the Land, is heated more

than the Sea-air, it becomes thereby more rarefied, and conſequently lighter; and therefore the Sea-air, with its ſuperior Weight, flows in upon it every Way. The Intervals between are owing to the Air of both Places being in an equal Degree of Heat, and conſequently of equal Weight.

The Trade-wind never varies, which is thus accounted for: The Air juſt under the Sun is the hotteſt: The cold Air preſſeth upon the hot, as the hot Air follows the Sun; and therefore it makes a perpetual Flow of Wind between the Tropics from *Africa* to *America*, and from thence to the *Eaſt-Indies*.

With regard to the Wind influencing the Weather; I find that though Air be an unmixed Fluid, yet it is capable of receiving many Vapours, which float in it, as we ſee other Bodies float in Water. Sometimes the Vapour aſcends, and ſometimes it falls to the Ground. All which I take to be effected by Heat and Cold in this Manner: Heat ſeparates Water into ſmall Particles, and the incorporated Air, rarefied by the ſame Heat, blows up thoſe Particles into Bubbles; by which means the ſwoln Vapour becoming ſpecifically lighter than a like Space of ambient Air, aſcends, ſwift, at firſt, (which affords a pleaſant Sight in a warm Summer's Day) and then gradually ſlower, till it gets up to that Part of the Air which is of equal Lightneſs with itſelf; and there it remains, as long as the Air continues in the ſame State: But whenever the Air cools, in which theſe watery Bladders float, the Cold contracts the Bladder, which becoming thereby ſpecifically heavier than the Air, down it falls in Dew, or Rain. A common

Alem-

Alembic ſufficiently ſhews the Operation of Heat and Cold on the aſcending and deſcending Vapour.

Thus in a calm Evening, when there is no Wind to waft the Air, as the Heat of the Sun declines, the Cold arreſts ſome few of the laſt aſcending Vapours, and, by its own Force, without any other Change in the State of the Air, compels them to return, in Dew, to the very Spot from whence they aroſe; whilſt their Brethren eſcape, who go out of the Reach of the Cold a little before the Approach of Night.

Since therefore the ſame Air, in different States of Heat and Cold, affects Vapour in this Manner, it thence follows, that Vapour, wafted from Air of one Temperament to another, muſt be affected in the ſame Manner alſo: So that Vapour, carried from a colder to a warmer Air, will aſcend; and, on the contrary, Vapour carried from a warmer to a colder Air, will deſcend.

Now if Cold condenſes the Air, and thereby makes it preſs upon the warmer; and if Vapour, carried by a Stream of Air from a colder to a warmer Region, aſcends; we have the Reaſon why the North-eaſt blows, and why it blows dry.

Let us fix upon ſome Spot in the Continent of *North-Europe*, whence this Wind comes to us: Suppoſe *Archangel*, which lies on our North-eaſt Point, and is in 65 Degrees Northern Latitude: When the Froſt is intenſe, the incumbent Air there muſt needs be very heavy; that Air will preſs every Way: *Quà data porta, ruit.* Let us conſider which Way this condenſed Air can burſt out from thence: It cannot go to the North, where the Cold is greater;

nor to the Eaſt, for the Air over the large Continent of *Tartary* is at leaſt of equal Coldneſs with itſelf. I make no doubt but they complain at *Archangel*, in their Turn, of cold North and North-eaſt, and even Eaſt Winds, as much as we do here. The great Continent to their South muſt be ſo cold as to make a ſtrong Reſiſtance: To the Weſt, the Air might find a free Paſſage over the Ocean, were not the Colds of *North-America* too near. The main Outlet is between both, towards the *Atlantic Ocean*: The warm Air over which being able, of itſelf, to make but a feeble Reſiſtance, yields to the ſuperior Force; the Conqueror eagerly purſues his Victory, and we, happening to lie directly in the Way, feel then a cold dry North-eaſt Wind: This is the Wind that brings us Froſt in the Winter. When the Winter is ſevere, it continues to blow all the Spring, and its Influence reaches to the End of the Summer.

This, I think, ſufficiently proves, that Air, flowing from a cold to a warmer Quarter, will blow dry: But, like a willing Witneſs, it proves too much; for, if Wind proceeds only from cold Air preſſing upon hot, and if Heat makes the Vapour aſcend, it follows from thence, that Wind can never bring Rain; whereas we find the contrary by ſad Experience; the South-weſt Wind hath ruled theſe Two Years, and ſtill doth rule.

How can this be accounted for, upon the Principles commonly received? That Vapour, wafted from a warmer to a colder Region of Air, ſhould precipitate, is what I have already ſhewn. But the Queſtion is, which I have not as yet ſeen anſwered, Why does the South-weſt blow? What is the Cauſe why a Stream of

of Air ſhould be carried, for ſo long a Time, and with ſo great Violence, as we have often felt, from a warmer to a colder, from a rarer to a denſer, from a lighter to a heavier Quarter? To the North-eaſt of us lies the Continent of *North-Europe*, great Part of which is, in the Winter, deprived of the Sun's Heat, and conſequently very cold; on the other Side, to the South-weſt, lies the vaſt *Atlantic Ocean*. We find by Experience, that the Sea-ſhore is warmer than the Inland; that the Sea is warmer than the Shore; and that the Ocean is ſtill warmer than the Sea. Beſides, the more you go from hence towards the South, the nearer you go to the Sun; and the more North, the farther from it: This muſt make the South-weſtern Ocean much warmer than the Continent, that lies at an equal Diſtance, on the oppoſite Point: From this very warm Place, the Wind blows to a Place much colder; and yet there muſt be a natural Cauſe of all this apparent Contradiction to the Laws of Nature: Whether we can find it out or not, I ſhall attempt it at well as I can.

It will be in vain to ſeek for the Cauſe of this Wind in this Ocean itſelf, or in the Air over it, influenced only by the Sun, and the Surface of the Sea. But there may be *Tornados* in thoſe Seas: Our Seamen often meet them between the Tropics, ſeldom, as I am told, in the Ocean I am now ſpeaking of, which is to the North of the Northern Tropic. But were they more frequent and violent than they really are, yet they are not laſting, and therefore cannot produce a long ſteady Courſe of South-weſt Winds with us.

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My Conjecture is, that our South-weſt Wind is no other than an Eddy of the Trade-wind, reflected from *America* to us. Though we cannot ſee the Eddy of Air, as we do that of Water; yet we muſt be otherwiſe very ſenſible, that it makes a ſtrong Recoil, when it meets with lofty Buildings, Woods, Hills, *&c.* The more elaſtic any Body is, it rebounds with the more Agility; and the Experiments that have frequently been made, ſufficiently ſhew the vaſt Elaſticity of the Air. There can, I think, be no Difficulty in conceiving, that there may be an Eddy of Wind from that Part of *America* which lies under the Equinoctial Line, even to us, provided there be a ſufficient impelling Force, and due Reſiſtance, and a proper Direction.

The impelling Force is a ſteady briſk Stream of Air, flowing perpetually from *Africa* to *America:* The Strength of this Wind may be in ſome meaſure judged of, from what Sailors obſerve, and expreſs in their Language, thus: It commonly blows a good Top-ſail Gale, as we ſail large; and if we were to ſail on a Wind, our lower Sails would be enough. I am ſenſible of what every Map ſhews us now, that the Trade-wind does not blow exactly from Eaſt to Weſt: But though the Arrows are placed as if ſhot obliquely towards the Equinoctial, or rather towards a Line parallel to it, and diſtant from it between 4 and 12 Degrees North Latitude, yet they are all pointed Weſtward; and that, I preſume, will be as much to the Purpoſe I am upon, as if the whole Stream went due Weſt.

In order to gueſs at the Momentum of this repelling Force, we ſhould conſider the Breadth and Height

Height of that Part of the Trade-wind, which I ſuppoſe to be turned this Way.

With regard to the Breadth, I read in *Dampier*, that they meet the Trade-wind at about 30 Degrees on this Side the Line; as many Degrees on the other Side will make the Whole extend to 60 Degrees broad. Methinks I do not want ſuch a Breadth, nor indeed can I fairly expect it. For ſo much of this Wind as blows to the South of the moſt Eaſtern Point of *South America*, which, I think, is called *Cape St. Auguſtin*, ſhould turn off Southward; the reſt, which blows to the North of that *Cape*, I may lay Claim to. This *Cape* is in about 8 Degrees South Latitude, ſo that I may demand a Breadth of 38 Degrees; but I will make an Abatement: For though the Trade-wind, to the North of the Line, be ſometimes 30 Degrees broad, yet ſometimes it is not above 24 Degrees; which Variation depends, as I ſuppoſe, on the Sun's Place in the *Zodiac:* So that it is narroweſt in the Winter, and wideſt in the Summer. Taking it then at the narroweſt, when the Sun is in the Winter Solſtice, we ſhall have a Breadth of 32 Degrees: But I allow 2 Degrees, to make Amends for the ſlack Wind, to the North of the Tropic of *Cancer*, and for the Calms near the Equator; and inſiſt on 30 Degrees only, for the Breadth of that Trade-wind, which is to be reflected back to us.

How high ſoever that Column of Air be, which is carried through this wide Space, no more of it can affect us, than what is repelled by the Hills it ſtrikes againſt, and by the cold Air which hangs over them.

I take theſe high Lands, and their incumbent Air, to be a Reſiſtance ſufficient to repel the Trade-wind: The

The Land muſt needs be ſo to its Height; and the Air over it, being many Degrees colder than the Trade-wind, will make a Reſiſtance in proportion to its ſuperior Weight. How high this Reſiſtance may be, I cannot pretend to determine: If I require no more than 3 Miles from the Surface of the Sea to the Top of the higheſt Ridge of Hills, within the Tract I am now ſpeaking of, and to the cold Air above them, I think I make but a modeſt Demand. Here, then, we have a Gale of Wind of the Breadth of 30 Degrees, 3 Miles high, carried with a great Velocity from *Africa* to *America*, a Momentum more than ſufficient to drive the Air from *America* to us, if there be but a proper Direction.

Were the whole Stream of the Trade-wind like a Mathematical Line, mere Length, without Breadth, and were this ſtrait Line to ſtrike on a ſmooth Surface of a given Inclination, we could know its Direction exactly. For it is a Rule in Geometry, that the Angle of Reflexion is equal to the Angle of Incidence. Suppoſe, for Example, that the Line of Trade-wind blew juſt South-eaſt, as it is ſaid to do, South of the Equator; that the Surface it ſtruck againſt ran exactly from South to North, as the Hills of *Peru* do; and that the Point of Incidence were under the Equator; in this Caſe the Angle of Incidence will be half a Right Angle, or an Angle of 45 Degrees, and conſequently the Angle of Reflexion will be 45 Degrees: Now, as theſe Degrees, when the reflected Line ſhall have run 90 Degrees in Length, will be equal to Degrees of a great Circle, and as we are about 90 Degrees Eaſt of this ſuppoſed Place of Contact, therefore this reflected Line will,

in

in our Longitude, reach to 45 Degrees of North Latitude, which is about *Bordeaux*. If we ſhould ſuppoſe the whole Breadth of the Trade-wind to conſiſt of an infinite Number of parallel Lines, falling on a Surface of the ſame Inclination, then the reflected Lines will be all parallel, and conſequently the Angles will be all equal; but they will reach wider, according to the Diſtance of one Point of Contact from the other; ſo that if that Line, which fell on the ſuppoſed Surface under the Equator, be reflected to 45 Degrees North Latitude, that which fell on the ſame Surface to the North of the Equator, ſuppoſe in 23 Degrees Latitude, will reach to 68 Degrees North Latitude, which is to the Northward of the *Orcades*, and almoſt to the North Cape of *Norway*. Or if we ſuppoſe the Trade-wind to the North of the Equator, to flow directly North-eaſt, as it is alſo ſaid to do, and to ſtrike againſt a Surface inclining from South-eaſt to North-weſt, which is pretty near the Bearing of the *Iſthmus* that joins *North* and *South America*; in both theſe Caſes the Reflexion will be towards the North-eaſt.

But there is no depending on this way of calculating: Not that GOD does not act according to the exacteſt Rules of Geometry, in the Motion of the Winds, as well as in all other Parts of the Creation: But we do not know, at leaſt I am far from pretending to know, all the infinite Variety of Reverberations that the Wind muſt have, from the uneven Surfaces it ſtrikes againſt, between Cape *St. Auguſtin* and the Bottom of the Gulph of *Mexico*. I make no doubt but that different Parts of this Air are reflected a Thouſand different Ways; and yet that the

Whole afterwards unite, or the far greater Part, and flow this Way. I find myſelf under a Neceſſity of ſuppoſing what I cannot demonſtrate Mathematically, ſince I can aſſign no other Cauſe why the South-weſt Wind blows ſo long with us.

But there are ſome other Facts which ſtrongly ſupport my Hypotheſis; *viz.* Currents of the Sea, and the Wind in the *Atlantic* Ocean, to the Northward of the Trade-wind.

With regard to the Currents, *Dampier* tells us, it is generally obſerved by Seamen, that, in all Places where the Trade-wind blows, the Current moves the ſame Way with the Wind; and that though it be perceived moſt near the Shore, yet it makes no ſenſible Riſing in the Water, as the Tides do. He ſays, there is always a ſtrong Current ſetting from Cape *St. Auguſtin* Weſtward, occaſioned, as he remarks, by the South-eaſt Trade-wind driving the Surface ſlanting on the Coaſt of *Braſil*; which, being there ſtopped by the Land, bends its Courſe Northerly, towards Cape *St. Auguſtin*; and, after it has doubled that Promontory, it falls away towards the *Weſt-Indies*, down along the Coaſt Weſtward, till it comes to Cape *Gratia de Dios*; from thence North-weſt towards Cape *Catoch* in *Jucatan*, thence to the Northward between *Jucatan* and *Cuba*. He ſays, that in the Chanel, between *Jucatan* and *Cuba*, he has found the Currents extraordinary ſtrong; that it is probable, that the Current which ſets to Leeward, on all the Coaſt from Cape *St. Auguſtin* to Cape *Catoch*, never enters the Bay of *Mexico*, but bends ſtill to the Northward, till it is checked by the *Florida* Shore; and then wheels about to the Eaſt, till

till it comes near the Gulph's Mouth, and paſſes with great Strength through the Gulph of *Florida*, which is the moſt remarkable Gulph in the World for its Currents, becauſe it always ſets very ſtrong to the North.

Thus far this Pilot: And, if too great a Fondneſs for my own Conjecture does not prejudice me very much, I may venture to ſay, that theſe Obſervations ſtrongly confirm it. He takes notice of the firſt Current which the Trade-wind makes near the Shore at Cape *St. Auguſtin*, where it is ſtrong; thence he traces it from one Cape to another, as it winds about by different Directions, yet ſtill gathering Strength at every Turning: It is extraordinary ſtrong between *Jucatan* and *Cuba*, but ſtrongeſt at the End of its Courſe in the Gulph of *Florida*. This Acquiſition of Strength upon a new Direction, is contrary to the Laws of Motion; therefore it muſt be owing to a freſh Supply, which the reſt of the Current, cauſed by the Trade-wind, gives it, till at length the whole Power, joined together, ruſhes out into the *Atlantic* Ocean.

Let us then ſuppoſe the Wind, which drives this Water before it, to follow it much in the ſame Courſe; and that, inſtead of ſtriking againſt one plain Surface, with ſuch an Inclination as would direct it to us, it ſtrikes againſt a Million, yet ſtill bending this Way: Let this natural Suppoſition be admitted, and we have the very Thing ſought for, *viz.* a proper Direction.

The other Fact is this: That when our Ships return from the *Weſt-Indies* through the Gulph of *Florida*, and are got into the wide Ocean, they have a regular

Wind at South-weſt, or near that Point, which ſometimes attends them to their very Port. This Wind cannot have its Riſe in that Ocean, nor can it come from any Continent that lies to the North, or even Weſt of it; therefore I conclude, that it muſt be an Eddy of the Trade-wind.

But to all this it may be objected, that the Sea-current ſets out of the Gulph of *Florida* towards the North; whereas, I ſay, the Wind comes towards the North-eaſt. Sailors, it ſeems, take no farther Notice of theſe Currents, than while they are near Head-lands, where they are ſtrongeſt, and affect their Navigation moſt. But there ſeems to me to be a Neceſſity of the Continuance of this Current much farther than the Gulph of *Florida*, and of its taking new Directions from the North towards the North-eaſt, and thence even towards the South, before it be quite ſpent. For it muſt be a vaſt Quantity of Water that is driven by the whole Breadth of the Trade-wind, from *Africa* to the Shores of *America*; the far greater Part of which, as *Dampier* ſuppoſes, doth flow by the Promontory of Cape *St. Auguſtin* Weſtward. This great Flux of Water has found a Paſſage out towards the North, between *Florida* and *Cuba*; which is the Reaſon, that, notwithſtanding the Current ſets Weſtward, the Sea in the *Weſt-Indies* never riſes. Here we ſee, that the Middle Ocean is at a great and conſtant Expence of Water; it muſt therefore want a Supply, and no Supply ſo natural, as for it to have its own Water again; which, after it hath paſſed the Gulph of *Florida*, meets with one Check ſtill after another, till it returns to the Place from whence it came.

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For the ſame Reaſon we may ſuppoſe, that though the Eddy of the Trade wind ſhould be reflected due North, from the Land it firſt ſtrikes againſt; or even though it ſhould undergo as many Turnings as the Surface of the Sea it drives before it; yet it may take a new Direction in the Ocean, cauſed by the Winds that blow from the Continent of *North America.*

Another Objection may be made againſt the South-weſt Wind being an Eddy of the Trade-wind, from what I myſelf have advanced, *viz.* that Cold is the Cauſe of Wind: That the *Atlantic* Ocean is too warm to produce this Wind; and yet that it comes from the Trade-wind, which blows between the Tropics, a Place much warmer: So that, according to this, here is a very warm Wind making its Way againſt the Cold of the North.

That Wind will blow from a warmer to a colder Quarter, is confirmed not only from the South-weſt raging with us in Winter, which muſt be confeſſed to come from a much warmer Climate, whatever Cauſe it be owing to; but from the almoſt daily Obſervation of thoſe who live in the Country, and will look a little about them. Whoever is within the Sight of Hills, and there are few Places where there are not ſome in View, will find, if he takes the leaſt Notice, that it rains in the Hills before it rains in the Vales: What can be the Cauſe of this Rain? Nothing, doubtleſs, but a Wind blowing from the Vales towards the Hills; that is, from a warmer to a colder Region, where the Vapour, which is brought thither, falls. Suppoſe the Air over the Hills be cold in 20 Degrees, and the Air over the Vales but in 10 Degrees, 10 cannot outweigh 20; but,

but, if it gets an additional Force of 30, it will then be double the Strength of 20; and, conſequently, blow from a warmer to a colder Quarter.

The *Momentum* of every Thing that moves, is made up of Two Powers, Weight and Velocity, multiplied by one another. This is fully ſhewn in the Butcher's Stiliard, which, with a Weight of 5 Pound, will weigh 100 Pound, by placing the 5 Pound Weight 20 times farther from the Centre, than the Thing to be weighed is placed: For 5 Pound the Weight multiplied by 20, the Velocity is equal to 100 Pound. Suppoſing then that the Cold to the North-eaſt of us be 100, and the Cold which drives the Trade-wind, only 5; that is, that the Cold of the one Place be 20 times greater than the Cold of the other: But ſuppoſing the Air 5 Degrees cold, to move 20 times faſter than that which is 100 Degrees; upon this Suppoſition the *Momentum* will be equal: And ſince they move in direct Oppoſition to one another, they will meet exactly half way, which I take to be ſometimes near the Caſe. But if the Northern Power ſhould loſe one Half of its Weight, *i. e.* be milder, by one Half, one Winter than it is another, the other Power ſtill continuing the ſame, then the South-weſt will blow one Half farther.

I am aware of but one Objection more, which is, that in the Gulph of *Florida*, through which I ſuppoſe the Trade-wind to flow towards us, there are variable Winds, which muſt interrupt this Stream, if there be any; ſince the ſame Air cannot flow different Ways at the ſame time.

It is no new thing to have variable Winds near the Land, even in the midſt of the Way of the Trade-wind.

wind. The Weſterly Winds, which, as *Dampier* ſays, blow on the Coaſt, between Cape *Gratia de Dios*, and Cape *La Vela*, are a Proof of it. The common Trade-wind on this Coaſt is between North-eaſt and Eaſt; but from *October* till *March*, and chiefly in *December* and *January*, the Winds blow Weſt; and yet when they are longeſt and ſtrongeſt on the Coaſt, the Eaſterly Trade-wind blows off at Sea, as at other times. Near Cape *La Vela*, the true Trade blows within 8 or 10 Leagues off the Shore, when the Weſterly Winds blow on the Coaſt. This ſhews that theſe Land-winds reach but a little Way, and therefore can have but a ſmall, if any, Influence on the main Stream of the Trade-wind.

In ſmaller Navigations here in *Europe*, they find the Wind out at Sea different from what it is near the Shore, and eſpecially near Head-lands, where it generally blows hardeſt, and which helped to make the Navigation of the Antients, in the *Mediterranean*, ſo tedious and dangerous. Theſe variable Coaſt-winds may be owing to great Snows, or Rains that fall upon Highlands, when there is none, or little, at Sea, or to ſome Storms of Thunder that burſt over them, or to their natural Coldneſs, or even to the Repercuſſion of the Air. I take the variable Winds they meet on the Coaſt of *Florida*, to be owing to the like Cauſes, which have their Influence but a little Way.

But it may be ſaid, that theſe variable Winds on the Coaſt of *Florida* are found ſo near the Trade-wind, that there is no Room between them for the Eddy of the Trade-wind, I am ſpeaking of, to paſs out. It may be Fact, for aught I know: I will ſup-

poſe

poſe it to be Fact. But I deſire the Objector to conſider, that, when he is ſailing, he is on the Top of the Water, and at the Bottom of the Air; he perceives the Current of Water run very faſt at Top, but does not know how it runs at the Bottom. It is very certain, that there are Under-currents in Water: In Rivers that ebb and flow, it is perceived every Tide; for the Current will run up after it hath begun to ebb. By Experiments that have been made, it appears, that in ſome Places, where the Current on the Surface is very ſtrong, the Under-current, running quite the contrary Way, ſhall be much ſtronger, and carry away a Boat againſt the Force of the upper Current.

And why may there not be contrary Currents in the Air? An Element much more ſubtile than Water, and therefore capable of being put into a greater Variety of Motions. The Sailor concerns himſelf no farther with the Wind, than as it fills his Sails, the Height of which can bear but a ſmall Proportion with that Column of Air I am now ſpeaking of. The Land-breezes about Iſlands, in the Torrid Zone, ſhew different Currents in the Air. For, in the Night, the Wind ſhall blow from the Centre of the Iſland, every Way, into the Sea, and even in direct Oppoſition to the Trade-wind, and yet give no Interruption to the Progreſs of it, except juſt in that little Spot, and for a ſmall Height too; which is evident from hence, becauſe in ſailing to the Weſtward of *Barbadoes*, ſuppoſe, or *Jamaica*, without the Reach of the Land-breeze, you feel no Interruption in the Strength of the Trade-wind, by Night as well as by Day.

I,

I, who am one of no great Obſervation, have frequently ſeen different Currents in the Air, at the ſame Time, and in the ſame Quarter, under one another. For Example: When the under Current has been Eaſt, the upper Current has been South-weſt, and the middle South-eaſt. I ſhall appear ridiculous, if I ſay I ſee the Wind; the Vulgar think, that Swine only are endowed with that Quickneſs of Sight. I do not ſay, that I can ſee the Wind; but I have often ſeen Clouds, Weather-cocks, Smoke, and ſuch-like Things, that are either carried or turned by the Wind. Smoke and Vanes are ſo near, that they can hardly cauſe any Deception; ſome Clouds may, unleſs properly obſerved: For when there are Two Tire of Clouds, both carried the ſame Way, and with the ſame Velocity, the upper Tire ſhall appear to move directly contrary to the lower; which Deception is owing to the different Angles that Objects of the ſame Magnitude, at different Diſtances, make on the *Retina*.

The way to obſerve the Motion of the Clouds, is by looking at them and a fixed Object at the ſame time, as the Sun and Stars, ſometimes: The beſt ſuperior fixed Object is the Moon in her Quarters, which may be then ſeen by Day-light, without offending the Eye. The fixed Objects below the Clouds are, a Ridge of Hills, lofty Buildings, or, for want of them, a Tree. By obſerving a Cloud with any fixed Object, you will not only ſee on what Point of the Compaſs the Clouds paſs; but you will ſee alſo the Motion of the upper and under Current: By this means you will find, as the Caſe happens, either both Currents going the ſame Way, though with different

apparent Velocity; or the upper Current going one Way, and the lower another, and perhaps you will ſee the Smoke going a Third. This ſufficiently ſhews, that there are different Currents in the Air.

From all my little Obſervation I find, that the upper Current generally prevails. For though the under Currents from, ſuppoſe, the Eaſt, or even North-eaſt, be brisk at firſt, and the brisker they are at firſt, the longer they continue; yet they die away by degrees, as their Strength ſpends itſelf; the Air becomes near calm, and then the South-weſt, which before blowed aloft, deſcends to the Earth, and commands the whole Sky.

That the Diſorders of the lower Air do not affect the Stream above, appears alſo from the Trade-wind paſſing over the very Continent, from the Eaſtern to the Weſtern Side of *America*. I make no doubt but the high Hills of *Peru* cauſe a greater Variety of Winds and Weather, than we have here. Their Weſtern Sea ſhews, that the lower Part of the Trade-wind meets with great Obſtructions in paſſing over the Continent. For, as *Dampier* obſerves, you do not meet with the true Trade-wind, till you are got 150 or 200 Leagues from Shore; and then it blows in its uſual manner. If all the Diſturbance that the high Hills of *Peru*, ſaid to be the higheſt in the World, give to the Trade-wind blowing over them, cannot intercept the upper Stream, which, after ſurmounting all thoſe Heights, and the Diſorder that their Cold occaſions, ſtoops down again, till it comes to touch once more the Surface of the Ocean; we may eaſily ſuppoſe, that that Part of the Trade-wind, which is reflected from theſe Hills towards the North-eaſt,

caſt, may diſengage themſelves, in like manner, from all inferior Obſtructions, and fly over all the little low Diſorders of the *Floridan* Coaſt.

Upon the Whole, then, though I cannot pretend to find out the Angle of Incidence, yet I muſt conclude, that the Trade-wind is reflected in ſuch a manner as to cauſe our South-weſt Wind.

And I conceive, that this new Direction is ſo far from checking its Current, that it the rather increaſes it. For a great Part of the cold Air, that hangs over the Continent it ſtrikes againſt, having no other Vent, flies off with the Eddy, and thereby makes more than Amends for the Stop it gave.

From *America* to the Weſt of *England* this Wind glides over the Ocean, a plain Field, that gives no Oppoſition, and which, with its natural Warmth, encourages the Waft, by making the Air over it more ready to yield to the impelled Force.

Having thus opened a Paſſage for the Trade-wind to flow even to us, with a back Stream, if my Conjecture hath opened it; what I have ſaid may ſerve as a Hint to thoſe who have better Materials, and can make a better Uſe of them: But, admitting that my Conjecture is right, we have the Cauſe why the South-weſt Wind blows with us; and then there can be no great Difficulty in finding out the Reaſon why it brings ſo much Rain.

For this Wind blowing over a warm Ocean, which ſends up many Vapours, by the time it reaches us, comes charged with an infinite Swarm of watery Bladders, which the Cold of this Climate condenſes, and then down they fall in Showers of Rain.

From hence it appears, that the Two great Rulers of the Weather with us are the North-eaſt and South-weſt Winds. Like Two neighbouring potent Monarchs, they are engaged in eternal Wars: Sometimes the one puſhes his Conqueſt with great Rapidity; and ſometimes the vanquiſhed Power not only recovers its loſt Dominions, but carries on the War into his Enemy's Territories with great Succeſs. As we happen to lie near their Frontiers, we feel, by turns, the different Effects of their fierce Contention: Some Years we have a Run of North-eaſt Winds, froſty Winters, and dry Summers; and ſome Years the Reverſe of all this.

But if I have hit upon the true Cauſes of theſe Winds, yet the Queſtion will be, On which Side lies the Redundancy, or Failure, that makes all this irregular Variation? For, between Two Antagoniſts, the Advantage will be the ſame to the Conqueror, whether his Superiority be owing to his own Strength, or the Weakneſs of his Adverſary. I would be glad to find this out, but I doubt that all my little Search will not be able to do it. I will proceed as far as I can.

Let us ſuppoſe, in the firſt Place, the North to be intirely paſſive, and that all the Variation of Cold and Heat is owing wholly to a Defect, or Exceſs, in the South-weſt Wind: So that, when the South-weſt blows, it ſhall be always warm; and, when it ceaſes to blow, it ſhall be ever cold. If this be Fact, then it will follow, that whilſt the South-weſt blows with the ſame ſteady Gale, the Weather ſhall be of the ſame Degree of Heat: But we find it otherwiſe; for the Nights, in a mild Winter, are colder than the Days,

Days, the ſame South-weſt ſtill blowing; therefore Cold, with us, is not wholly owing to a Slackneſs of the South-weſt Winds.

Let us now ſuppoſe the Privation of the Sun's Heat to be the only Cauſe of Cold: The Conſequence will be, that all Places equally diſtant from the Sun, will be equally cold. But it is well known, that, in the ſame Northern Latitude in *Europe*, Cold is greater on the Continent than in Iſlands: Therefore Privation of the Sun's Heat is not the only Cauſe of Cold. The Sun's Abſence, like other negative Cauſes, can amount only to the Removal of an Obſtruction which hindered the efficient Cauſe of Cold, whatever it be, from acting.

Since the larger the Tract of Earth, the greater the Cold, the efficient Cauſe of Cold ſeems to be in the Earth; and yet, when we deſcend a little Way under-ground, not only in Mines, but in ſome Cellars, we find an even Temperament: We muſt therefore confine this efficient Cauſe of Cold to the Earth's Surface.

But if the Earth's Surface be the ſole efficient Cauſe of Cold, ſince the Surface of the Earth ſtill continues the ſame, the Cold ſhould be the ſame on that Surface every Winter; whereas we find it otherwiſe. We muſt, therefore, ſeek for ſome concurrent Cauſe, between whom and the Earth's Surface this Cold is generated; and that, I think, can be no other than what is carried on the Wings of the Wind.

Dampier obſerves, that, after a *Tornado* at Land in *Jamaica*, the Land-wind will begin by Four or Three o'Clock in the Afternoon. The Materials of this

this *Tornado* muſt be carried thither by the Wind; where the *Tornado* burſts, it cools the Air; which makes the Land-breeze begin ſome Hours ſooner than its uſual Courſe.

That the South-weſt Wind, warm as it is, carries with it the Seeds of Cold, is evident from thoſe violent Storms of Thunder, attended with great Rains, and large Hailſtones, ſeveral of which happened this laſt Summer.

The 8th of laſt *September* was a cold Winter's Day at the Place where I dwell. In the Morning, when I awoke, I perceived a great Dew on the Inſide of the Glaſs of my Chamber-window: When I went out, I obſerved the Wind to be North-eaſt, ſtrong, black Clouds, and little Rain early, reſt dry. 9th in the Morning, the Wind was North-eaſt, brisk, dry. I began to think, that the Winter was going to ſet in very ſevere; but I was in a little time undeceived. The Afternoon of the 9th was overcaſt. On the 10th, I ſaw Colts-tails, as the Sailors call them: I take them to be *Virgil's Tenuia lanæ vellera:* Marks of Rain, that ſeldom deceive thoſe who are uſed to obſerve them. On the 11th, the Wind returned again to its old Point of South-weſt, with Rain. Some time after, I did read in the News-papers, that on the 7th a violent Storm fell about *Worceſter*, which is diſtant from hence about 2 Degrees, and bears, nearly, on the North-eaſt Point. Then I found out the Cauſe of that little Winter.

I could mention more Facts of this Kind, but theſe, I believe, are enow to ſatisfy us, that the Seeds of Cold are carried on the Wings of the Wind. It will be needleſs to take notice, that the Wind carries the Cold

Cold back again: Every one who feels his Hands tingle in a froſty Morning, and looks at the Weather-cock, muſt be ſenſible of it.

Since, therefore, a large Surface of Earth to the North of us, aſſiſted only with a Privation of the Sun's Heat, cannot produce Cold to ſo great a Degree, as to affect the Weather with us; and ſince it appears, that that which is to help theſe Two Cauſes to produce ſuch a Cold, is brought by the Winds, and carried off again; I muſt conclude, that there are frigorific Particles floating in the Air, whether they be Nitre, or by whatever Name the Chymiſts will call them; that they are always acting, unleſs obſtructed by other Cauſes; and that, when they find a proper Recipient, and all Obſtructions be removed, they act with Vigour.

When I ſpeak of the Seeds of Cold, I do not mean, that Cold acts as a Vegetative: Though whoever conſiders the Order that Froſt obſerves in building its Ice upon the Water, will be apt to think, that if it be not the Effect of Vegetation, it is ſomething that reſembles it very near.

It firſt ſhoots out a ſmall ſtrait Twig; then, from the ſame Centre, one on each Side; from theſe main Beams dart out ſmaller Sprigs on each Side, to form the Contignation; then theſe Rafters ſending forth their Sprays, the whole Floor is laid, weak at firſt; but as they gather Strength, they make a Plancher, ſtrong enough, ſometimes, to bear the Weight of whole Armies paſſing over the *Baltic*.

I do not expect, that the Ladies will expoſe themſelves ſo much to the Cold, as to ſee all this: But if they pleaſe to give themſelves only the Trouble to look

look on their Chamber-windows in a frosty Morning, if they rise soon enough, and they will see there such Embroidery made by Ice, as their own Fingers, were they used to work, and the finest Needles, could not equal.

All this, I say, would tempt one to imagine, that there is something vegetative in what I call the Seeds of Frost. But that is not what I am about at present. All I contend for now is, that that which co-operates with the Earth's Surface, to produce Cold, which way soever it produces it, is carried to and fro by the Air.

Instead of their acting like Seeds, let us suppose them to act like inanimate Bodies: That each Particle acts with a determined Force; and that, consequently, the more of them act together, the greater their Effect. Upon this Supposition we can easily account for the different Temperament of the Air in the same Seasons. For a Continuance of North-east Winds for some Years will carry off many of these Seeds, or Grains of Cold; and an equal Continuance of South-west Winds will bring them back again; and these Periods will be longer or shorter, according to the Strength or Weakness of the Blast.

And thus, at length, I have satisfied myself, till I can find out a better Reason, why a cold frosty Winter produces a dry Summer; and a mild Winter a wet Summer. For these Seeds of Cold being the chief Cause of Frost, and their Strength being in Proportion to their Number, when the Winter is severe, there is so vast a Quantity of these frigorific Particles in *North-Europe*, that their Strength will not soon be exhausted; and, consequently, that the North-east Winds

Winds will blow long, and make the Summers dry.

But, on the contrary, when the Winter is mild, there are but a few of thoſe Particles in *North-Europe*, not enough to cool the Air there to ſuch a Weight, as to enable it to hinder the South-weſt from reaching us, even in Winter; and therefore, when once the Sun's Heat comes to deſtroy thoſe few, the South-weſt, which is always acting with equal Force, prevails, and brings Rain in Summer.

I make no doubt, but that a Courſe of Obſervations, kept for ſome Years, in ſeveral Places, would reduce the Knowledge of theſe Viciſſitudes of Wind and Weather to ſome Certainty.

I have taken notice only of Two Winds, the North-eaſt and South weſt, as the Producers of a long Run of dry or wet Weather: But if I have hit upon the true Cauſes of thoſe Winds, the ſmaller Variations may be eaſily accounted for. I ſhall mention a few.

Next to thoſe Two, the North-weſt Wind blows longeſt here, and with the greateſt Force, but with various Effects. Sometimes it conſpires with the South-weſt, to blow a mere Storm, with hard Rain; and ſometimes it takes part with the North caſt, blows dry, and freezes. We are, in a great meaſure, beholding to this Wind, for the little dry Weather we have in a mild Winter.

I take this Wind to proceed from the Continent of *North-America*, where the Cold muſt needs be very intenſe, that can drive the Air from thence hither, with ſuch ſtrong Guſts. It is well known, that Places of the ſame Northern Latitude are much

colder in *America* than in *Europe*. Upon Suppoſition that the North-weſt Wind blows from *North-America*, I can, methinks, eaſily account for all theſe contrary Effects produced by the ſame Wind.

Though it blows from a cold to a warmer Quarter, yet it brings Rain at firſt, for this Reaſon, becauſe the Air over the Ocean about us is warmer than that over us. When the North-weſt begins to blow, it muſt drive the Air before it; and then the Vapour that floated in warm Air will fall down with us. Even the North-eaſt, the drieſt and coldeſt Wind we have, will bring Rain, and for many Hours, when it ſets in after a South-weſt.

Hence alſo it is that the South-eaſt and South Winds bring much Rain, and for many Hours together. I take the South-eaſt to come from the *Alps*, and the South from the *Pyrenees*.

I ſhall, at preſent, run no farther into Particulars; my Deſign being only to inquire into the Cauſes of a long Continuance of dry or wet Weather. It would be endleſs to enter into all the Predictions of Weather, that may be collected from Books, and private Obſervations: Moſt of them pretend to foretel the Weather no farther than a few Days. If thoſe Predictions and my Hypotheſis be founded on Nature, they will all admit of the ſame, or of a conſiſtent Explanation.

N. F. Dec. 31. 1735.