II. *The Effects of* Cold; *together with Obſervations of the* Longitude, Latitude, *and* Declination *of the* Magnetic Needle, *at* Prince of Wales's Fort, *upon* Churchill-River *in* Hudſon's Bay, North America; *by Capt.* Chriſtopher Middleton, F. R. S. *Commander of His* MAJESTY'S *Ship* Furnace, 1741-2.

Read Oct. 28. 1742.

I Obſerved, that the *Hares*, *Rabbets*, *Foxes* and *Partridges*, in *September*, and the Beginning of *October*, changed their native Colour to a ſnowy White; and that for Six Months, in the ſevereſt Part of the Winter, I never ſaw any but what were all white, except ſome *Foxes* of a different Sort, which were grizzled, and ſome half red, half white.

That Lakes and ſtanding Waters, which are not above 10 or 12 Feet deep, are frozen to the Ground in Winter, and the Fiſhes therein all periſh.

Yet in Rivers near the Sea, and Lakes of a greater Depth than 10 or 12 Feet, Fiſhes are caught all the Winter, by cutting Holes through the Ice down to the Water, and therein putting Lines and Hooks. But if they are to be taken with Nets, they cut ſeveral Holes in a ſtrait Line the Length of the Net, and paſs the Net, with a Stick faſtened to the Head-line, from Hole to Hole, till it reaches the utmoſt Extent; and what Fiſhes come to theſe Holes for Air, are thereby entangled in the Net; and theſe Fiſh, as ſoon

as brought into the open Air, are inſtantaneouſly frozen as ſtiff as Stock-fiſh. The Seamen likewiſe freſhen their ſalt Proviſions, by cutting a large Hole through the Ice in the Stream or Tide of the River, which they do at the Beginning of the Winter, and keep it open all that Seaſon. In this Hole they put their ſalt Meat, and the Minute it is immerſed under Water, it becomes pliable and ſoft, though before its Immerſion it was hard frozen.

Beef, *Pork*, *Mutton*, and *Veniſon*, that are killed at the Beginning of the Winter, are preſerved by the Froſt, for Six or Seven Months, intirely free from Putrefaction, and prove tolerable good eating. Likewiſe *Geeſe*, *Partridges*, and other Fowl, that are killed at the ſame time, and kept with their Feathers on, and Guts in, require no other Preſervative but the Froſt to make them good wholſome eating, as long as the Winter continues. All kinds of Fiſh are preſerved in the like manner.

In large Lakes and Rivers, the Ice is ſometimes broken by impriſoned Vapours; and the Rocks, Trees, Joiſts and Rafters of our Buildings, are burſt with a Noiſe not leſs terrible than the firing off a great many Guns together. The Rocks which are ſplit by the Froſt, are heaved up in great Heaps, leaving large Cavities behind; which I take to be cauſed by impriſoned watery Vapours, that require more Room, when frozen, than they occupy in their fluid State. Neither do I think it unaccountable, that the Froſt ſhould be able to tear up Rocks and Trees, and ſplit the Beams of our Houſes, when I conſider the great Force and Elaſticity thereof. If Beer or Water is left in Mugs, Cans, Bottles, nay in Copper Pots, though they

they were put by our Bed-ſides, in a ſevere Night they are ſurely ſplit to pieces before Morning, not being able to withſtand the expanſive Force of the incloſed Ice.

The Air is filled with innumerable Particles of Ice, very ſharp and angular, and plainly perceptible to the naked Eye. I have ſeveral times this Winter tried to make Obſervations of ſome celeſtial Bodies, particularly the Emerſions of the Satellites of *Jupiter*, with reflecting and refracting Teleſcopes; but the Metals and Glaſſes, by that Time I could fix them to the Object, were covered a quarter of an Inch thick with Ice, and thereby the Object rendered indiſtinct, ſo that it is not without great Difficulties that any Obſervations can be taken.

Bottles of *ſtrong Beer*, *Brandy*, *ſtrong Brine*, *Spirits of Wine*, ſet out in the open Air for Three or Four Hours, freeze to ſolid Ice. I have tried to get the Sun's Refraction here to every Degree above the Horizon, with *Elton*'s Quadrant, but to no Purpoſe, for the Spirits froze almoſt as ſoon as brought into open Air.

The Froſt is never out of the Ground, how deep we cannot be certain. We have dug down 10 or 12 Feet, and found the Earth hard frozen in the Two Summer Months; and what Moiſture we find Five or Six Feet down, is white like Ice.

The Waters or Rivers near the Sea, where the Current of the Tide flows ſtrong, do not freeze above Nine or Ten Feet deep.

All the Water we uſe for Cooking, Brewing, *&c.* is melted Snow and Ice; no Spring is yet found free from freezing, though dug never ſo deep down. All Waters

Waters in-land are frozen faſt by the Beginning of *October*, and continue ſo till the Middle of *May*.

The Walls of the Houſe we live in are of Stone, Two Feet thick, the Windows very ſmall, with thick wooden Shutters, which are cloſe ſhut 18 Hours every Day in the Winter. There are Cellars under the Houſe, wherein we put our *Wines*, *Brandy*, *ſtrong Beer*, *Butter*, *Cheeſe*, &c. Four large Fires are made in great Stoves, built on purpoſe, every Day: As ſoon as the Wood is burnt down to a Coal, the Tops of the Chimneys are cloſe ſtopped with an Iron Cover: This keeps the Heat within the Houſe (though at the ſame time the Smoke makes our Heads ake, and is very offenſive and unwholſome); notwithſtanding which, in Four or Five Hours after the Fire is out, the Inſide of the Walls of our Houſe and Bed-places will be Two or Three Inches thick with Ice, which is every Morning cut away with a Hatchet. Three or Four times a Day we make Iron Shot of 24 Pounds Weight red-hot, and hang them up in the Windows of our Apartments. I have a good Fire in my Room the major Part of the 24 Hours, yet all this will not preſerve my *Beer*, *Wine*, *Ink*, &c. from freezing.

For our Winter Dreſs we make uſe of Three Pair of Socks of coarſe Blanketting or Duffield for the Feet, with a Pair of *Deer-skin* Shoes over them; Two Pair of thick *Engliſh* Stockings, and a Pair of Cloth Stockings upon them; Breeches lined with Flannel; Two or Three *Engliſh* Jackets, and a Fur or Leather Gown over them; a large Beaver Cap, double, to come over the Face and Shoulders, and a Cloth of Blanketting under the Chin; with Yarn Gloves, and

a large Pair of Beaver Mittings hanging down from the Shoulders before, to put our Hands in, which reach up as high as our Elbows; yet notwithſtanding this warm Cloathing, almoſt every Day, ſome of the Men that ſtir abroad, if any Wind blows from the Northward, are dreadfully frozen; ſome have their Arms, Hands and Face bliſtered and frozen in a terrible manner, the Skin coming off ſoon after they enter a warm Houſe, and ſome have loſt their Toes. Now their lying-in for the Cure of theſe frozen Parts, brings on the Scurvy in a lamentable manner. Many have died of it, and few are free from that Diſtemper. I have procured them all the Helps I could, from the Diet this Country affords in Winter, ſuch as freſh Fiſh, Partridges, Broths, *&c.* and the Doctors have uſed their utmoſt Skill in vain; for I find nothing will prevent that Diſtemper from being mortal, but Exerciſe and ſtirring abroad.

Coronæ and *Parhelia*, commonly called *Halo's*, and *Mock-Suns*, appear frequently about the Sun and Moon here. They are ſeen once or twice a Week about the Sun, and once or twice a Month about the Moon, for Four or Five Months in the Winter, ſeveral *Coronæ* of different Diameters appearing at the ſame time.

I have ſeen Five or Six parallel *Coronæ* concentric with the Sun ſeveral times in the Winter, being for the moſt-part very bright, and always attended with *Parhelia* or *Mock-Suns*. The *Parhelia* are always accompanied with *Coronæ*, if the Weather is clear; and continue for ſeveral Days together, from the Sun's Riſing to his Setting. Theſe Rings are of various Colours, and about 40 or 50 Degrees in Diameter.

The

The frequent Appearance of theſe *Phænomena* in this frozen Clime ſeems to confirm *Deſcartes's* Hypotheſis, who ſuppoſes them to proceed from Ice ſuſpended in the Air.

The *Aurora Borealis* is much oftener ſeen here than in *England*; ſeldom a Night paſſes in the Winter free from their Appearance. They ſhine with a ſurpriſing Brightneſs, darkening all the Stars and Planets, and covering the whole Hemiſphere: Their tremulous Motion from all Parts, the Beauty and Luſtre, are much the ſame as in the Northern Parts of *Scotland* and *Denmark*, &c.

The dreadful long Winters here may almoſt be compared to the Polar Parts, where the Abſence of the Sun continues for Six Months; the Air being perpetually chilled and frozen by the Northerly Winds in Winter, and the cold Fogs and Miſts obſtructing the Sun's Beams in the ſhort Summer we have here; for notwithſtanding the Snow and Ice is then diſſolved in the Low-lands and Plains, yet the Mountains are perpetually covered with Snow, and incredible large Bodies of Ice continue in the adjacent Seas. If the Air blows from the Southern Parts, the Air is tolerably warm, but very cold when it comes from the Northward, and it ſeldom blows otherwiſe than between the North-eaſt and North-weſt, except in the Two Summer Months, when we have, for the major Part, light Gales between the Eaſt and the North, and Calms.

The Northerly Winds being ſo extremely cold, is owing to the Neighbourhood of high Mountains, whoſe Tops are perpetually covered with Snow, which exceedingly chills the Air paſſing over them.

The

The Fogs and Miſts that are brought here from the Polar Parts, in Winter, appear viſible to the naked Eye in Icicles innumerable, as ſmall as fine Hairs or Threads, and pointed as ſharp as Needles. Theſe Icicles lodge in our Cloaths, and if our Faces or Hands be uncovered, they preſently raiſe Bliſters as white as a Linen Cloth, and as hard as Horn. Yet if we immediately turn our Backs to the Weather, and can bear our Hand out of our Mittin, and with it rub the bliſtered Part for a ſmall time, we ſometimes bring the Skin to its former State: If not, we make the beſt of our Way to a Fire, and get warm Water, wherewith we bathe it, and thereby diſſipate the Humours raiſed by the frozen Air; otherwiſe the Skin would be off in a ſhort time, with much hot, ſerous, watry Matter coming from under along with the Skin; and this happens to ſome almoſt every time they go abroad for Five or Six Months in the Winter, ſo extreme cold is the Air when the Wind blows any thing ſtrong.

Now I have obſerved, that when it has been extreme hard Froſt by the Thermometer, and little or no Wind that Day, the Cold has not near ſo ſenſibly affected us, as when the Thermometer has ſhewed much leſs freezing, having a brisk Gale of Northerly Wind at the ſame time. This Difference may perhaps be occaſioned by thoſe ſharp-pointed Icicles before-mentioned ſtriking more forcibly in a windy Day, than in calm Weather, thereby penetrating the naked Skin, or Parts but thinly covered, and cauſing an acute Senſation of Pain or Cold: And the ſame Reaſon, I think, will hold good in other Places; for ſhould the Wind blow Northerly any thing hard for

many Days together in *England*, the Icicles that would be brought from the Polar Parts by the Continuance of ſuch a Wind, though imperceptible to the naked Eye, would more ſenſibly affect the naked Skin, or Parts but ſlightly covered, than when the Thermometer has ſhewn a greater Degree of freezing, and there has been little or no Wind at the ſame time.

It is not a little ſurpriſing to many, that ſuch extreme Cold ſhould be felt in theſe Parts of *America*, more than in Places of the ſame Latitude on the Coaſt of *Norway*; but the Difference I take to be occaſioned by Wind blowing conſtantly here, for Seven Months in the Twelve, between the North-eaſt and North-weſt, and paſſing over a large Tract of Land, and exceeding high Mountains, *&c.* as before-mentioned. Whereas at *Drunton* in *Norway*, as I obſerved ſome Years ago in wintering there, the Wind all the Winter comes from the North and North North-weſt, and croſſes a great Part of the Ocean clear of thoſe large Bodies of Ice we find here perpetually. At this Place we have conſtantly every Year Nine Months Froſt and Snow, and unſufferable Cold from *October* till the Beginning of *May*. In the long Winter, as the Air becomes leſs ponderous towards the Polar Parts, and nearer to an *Æquilibrium*, as it happens about One Day in a Week, we then have Calms and light Airs all round the Compaſs, continuing ſometimes 24 Hours, and then back to its old Place again, in the ſame manner as it happens every Night in the *Weſt-Indies*, near ſome of the Iſlands.

The

The Snow that falls here is as fine as Duſt, but never any Hail, except at the Beginning and End of Winter. Almoſt every Full and Change of the Moon, very hard Gales from the North.

The conſtant Trade Winds in theſe Northern Parts I think undoubtedly to proceed from the ſame Principle, which our learned Dr. *Halley* conceives to be the Cauſe of the Trade Winds near the Equator, and their Variations.

" Wind, ſays he, is moſt properly defined to be " the Stream or Current of the Air; and where ſuch " Current is perpetual and fixed in its Courſe, it is " neceſſary, that it proceed from a permanent and " unintermitting Cauſe, capable of producing a like " conſtant Effect, and agreeable to the known Pro- " perties of Air and Water, and the Laws of Motion " of fluid Bodies. Such an one is, I conceive, the " Action of the Sun's Beams upon the Air and Wa- " ter, as he paſſes every Day over the Oceans, conſi- " dered together with the Nature of the Soil and " Situation of the adjoining Continents. I ſay, " therefore, firſt, That according to the Laws of " *Statics*, the Air which is leſs rarefied or expanded " by Heat, and conſequently more ponderous, muſt " have a Motion towards thoſe Parts thereof which " are more rarefied, and leſs ponderous, to bring it to " an *Æquilibrium*, &c."

Now, that the cold denſe Air, by reaſon of its great Gravity, continually preſſes from the Polar Parts towards the Equator, where the Air is more rarefied, to preſerve an *Æquilibrium* or Balance of the Atmoſphere, I think, is very evident from the Wind in thoſe frozen Regions blowing from the North and

North-weſt, from the Beginning of *October* until *May*; for we find, that when the Sun, at the Beginning of *June*, has warmed thoſe Countries to the Northward, then the South-eaſt, Eaſt and variable Winds continue till *October* again; and I do not doubt but the Trade Winds and hard Gales may be found in the Southern Polar Parts to blow towards the Equator, when the Sun is in the Northern Signs, from the ſame Principle.

The Limit of theſe Winds from the Polar Parts, towards the Equator, is ſeldom known to reach beyond the 30th Degree of Latitude; and the nearer they approach to that Limit, the ſhorter is the Continuance of thoſe Winds. In *New-England* it blows from the North near Four Months in the Winter; at *Canada*, about Five Months; at the *Danes* Settlement in *Streights Davis*, in the 63d Degree of Latitude, near Seven Months; on the Coaſt of *Norway*, in 64, not above Five Months and a half, by reaſon of blowing over a great Part of the Ocean, as was before-mentioned; for thoſe Northerly Winds continue a longer or ſhorter Space of Time, according to the Air's being more or leſs rarefied, which may very probably be altered ſeveral Degrees, by the Nature of the Soil, and the Situation of the adjoining Continents.

The vaſt Bodies of Ice we meet with in our Paſſage from *England* to *Hudſon's-Bay*, are very ſurpriſing, not only as to Quantity, but Magnitude, and as unaccountable how they are formed of ſo great a Bulk, ſome of them being immerſed 100 Fathom or more under the Surface of the Ocean; and a Fifth or Sixth Part above, and Three or Four Miles in Circumference.

cumference. Some Hundreds of theſe we ſometimes ſee in our Voyage here, all in Sight at once, if the Weather is clear. Some of them are frequently ſeen on the Coaſts and Banks of *Newfoundland* and *New-England*, though much diminiſhed.

When I have been becalmed in *Hudſon's-Streights* for Three or Four Tides together, I have taken my Boat, and laid cloſe to the Side of one of them, ſounded, and found 100 Fathom Water all round it. The Tide floweth here above Four Fathom; and I have obſerved, by Marks upon a Body of Ice, the Tide to riſe and fall that Difference, which was a Certainty of its being aground. Likewiſe, in a Harbour in the Iſland of *Reſolution*, where I continued Four Days, Three of theſe Iſles of Ice (as we call them) came aground. I ſounded along by the Side of one of them, quite round it, and found 32 Fathom Water, and the Height above the Surface but 10 Yards; another was 28 Fathom under, and the perpendicular Height but Nine Yards above the Water.

I can in no other manner account for the Aggregation of ſuch large Bodies of Ice but this: All along the Coaſts of *Streights Davis*, both Sides of *Baffin's-Bay*, *Hudſon's-Streights*, *Anticoſh*, or *Labradore*, the Land is very high and bold, and 100 Fathoms, or more, cloſe to the Shore. Theſe Shores have many Inlets or Fuirs, the Cavities of which are filled up with Ice and Snow, by the almoſt perpetual Winters there, and frozen to the Ground, increaſing for Four, Five, or Seven Years, till a kind of Deluge or Land-flood, which commonly happens in that Space of Time throughout thoſe Parts, breaks them looſe, and launches them into the Streights or Ocean, where they

are

are driven about by the variable Winds and Currents in the Months of *June*, *July*, and *Auguſt*, rather increaſing than diminiſhing in Bulk, being ſurrounded (except in Four or Five Points of the Compaſs) with ſmaller Ice for many Hundred Leagues, and Land covered all the Year with Snow, the Weather being extreme cold, for the moſt part, in thoſe Summer Months. The ſmaller Ice that almoſt fills the Streights and Bays, and covers many Leagues out into the Ocean along the Coaſt, is from Four to Ten Fathom thick, and chills the Air to that Degree, that there is a conſtant Increaſe to the large Iſles by the Sea's waſhing againſt them, and the perpetual wet Fogs, like ſmall Rain, freezing as they ſettle upon the Ice; and their being ſo deeply immerſed under Water, and ſuch a ſmall Part above, prevents the Wind's having much Power to move them: For though it blows from the North-weſt Quarter near Nine Months in Twelve, and conſequently thoſe Iſles are driven towards a warmer Climate, yet the progreſſive Motion is ſo ſlow, that it muſt take up many Years before they can get Five or Six hundred Leagues to the Southward; I am of Opinion ſome Hundreds of Years are required; for they cannot, I think, diſſolve before they come between the 50th and 40th Degree of Latitude, where the Heat of the Sun conſuming the upper Parts, they lighten and waſte in Time: Yet there is a perpetual Supply from the Northern Parts, which will ſo continue as long as it pleaſes the AUTHOR of all Beings to keep things in their preſent State.

Ob-

Obſervations of the Longitude, Latitude, *and the* Declination *of the* Magnetic Needle, *at* Prince of Wales's Fort, Churchill-River.

	h.	′	″
Having obſerved the apparent Time of an Emerſion of *Jupiter*'s firſt *Satellite* at *Fort-Churchill*, on *Saturday* the 20th of *March* laſt 1741-2. at	11	55	50
I find the ſame Emerſion happened at *London*, by Mr. *Pound*'s Tables, compared with ſome Emerſions actually obſerved in *England* near the ſame, at	18	15	10
Whence the hoary Difference of Meridians, between *Fort-Churchill* and *London*, comes out	6	19	20
Which converted into Degrees of the Equator, gives for the Diſtance of the ſame Meridians	94°	50′	

Wherefore, ſince the Time at *London* was later in Denomination than that at *Churchill*, it follows that, according to this Obſervation, *Churchill* is 94 Degrees 50 Minutes, in Longitude Weſt of *London*.

I took ſeveral other Obſervations, which agreed one with another to leſs than a Minute, but this I look upon as the moſt diſtinct and beſt.

The Obſervation was made with a good 15 Foot refracting Teleſcope, and a Two Foot Reflector of *Gregory*'s Kind, having a good Watch of Mr. *Graham*'s that I could depend upon; for I have frequent Opportunities of diſcovering how much its Variation amounted to, and conſtantly found its daily De-

Deviation or Error to be 15 Seconds too ſlow; by which means it was as uſeful to me for all Purpoſes, as if it had gone moſt conſtantly true without any Change. This Watch I kept in my Fob in the Day, and in Bed in the Night, to preſerve it from the Severity of the Weather; for I obſerved, that all other Watches were ſpoiled by the extreme Cold.

I have found, from repeated Obſervations, a Method of obtaining the true Time of the Day at Sea, by taking Eight or Ten different Altitudes of the Sun or Stars, when near the Prime Vertical, by Mr. *Smith*'s or Mr. *Hadley*'s Quadrant, which I have practiſed theſe Three or Four Years paſt, and never found from the Calculations, that they differed one from another more than 10 or 15 Seconds of Time. This Certainty of the true Time at Sea is of greater Uſe in the Practice of Navigation, than may appear at firſt Sight; for you thereby not only get the Variation of the Compaſs without the Help of Altitudes, but likewiſe the Variation of the Needle from the true Meridian, every time the Sun or Star is ſeen to tranſit the ſame. Alſo having the true Time of Day or Night, you may be ſure of the Meridian Altitude of the Sun or Star, if you get a Sight 15 or 20 Minutes before or after it paſſes the Meridian; and the Latitude may be obtained to leſs than Five Minutes, with ſeveral other Uſes in Aſtronomical Obſervations; as the Refraction of the Atmoſphere, and to allow for it, by getting the Sun's apparent Riſing and Setting, which any body is capable of doing, and from thence you will have the Refraction.

If we had ſuch a Teleſcope contrived as Mr. *Smith* recommends to be uſed on Shipboard at Sea, now we can have an exact Knowledge of the true Time of the

the Day or Night from the above Inſtruments and a good Watch, I hope we ſhould be able to obſerve the Eclipſes of the firſt *Satellite* of *Jupiter*, or any other *Phænomenon* of the like Kind, and thereby find the Diſtance of Meridians, or Longitude at Sea.

The Variation of the Magnetical Needle, or Sea-Compaſs, obſerved by me at *Churchill* in 1725. (as in N° 393. of the *Philoſophical Tranſactions* for the Months of *March* and *April* 1726.) was at that Time North 21 Degrees Weſterly, and this Winter I have carefully obſerved it at the ſame Place, and find it no more than 17 Degrees, ſo that it has differed about One Degree in Four Years; for in 1738. I obſerved it here, and found its Declination 18 Degrees Weſterly. I have carefully obſerved, and made proper Allowance for the Sun's Declination and Refraction, and find the Latitude here to be 58 Degrees 56 Minutes North: But in moſt Parts of the World, where the Latitudes are fixed by Seamen, they are for the moſt part falſly laid down, for want of having regard to the Variation of the Sun's Declination, which, computed at a diſtant Meridian, when the Sun is near the Equator, may make a great Error in the Sun's riſing and ſetting *Azimuths*, &c.

Theſe things I thought proper to take Notice of, as they may be of Service to Navigators, and the Curious in Natural Inquiries.

The foregoing Relation having been given by Capt. *Middleton* to the late worthy Preſident of the ROYAL SOCIETY, Sir *Hans Sloane*, Bart. he was pleaſed to communicate the ſame to the SOCIETY, and at the ſame time, as the ſurviving Truſtee of the late Sir *Godfrey Copley*, to nominate Capt. *Middleton* to receive this Year the Prize Medal, given annually by the ROYAL SOCIETY, in Conſequence of Sir *Godfrey*'s Benefaction; and the ſame was accordingly preſented to the Captain on St. *Andrew*'s Day laſt, 1742.