by Chris Parker, Chief Forecaster

Saturday, February 8, 2020

Offshore Weather Forecasting & Routing for A2B Race


1452

Bio - Chris

- Interested in weather since age 4
- Studied 2 years in college
- I'm a weather expert
- I help people get to their destination safely, and enjoy their time in Paradise
- I've been a full time weather forecasting and routing vessels for over 15 years
- My experience is on small boats, I get seasick, and started with a fear of everything

Bio - Shawn

- Interested in weather since a young age
- I help people get to their destination safely, and enjoy their time in Paradise
- Graduated Virginia Tech with degree in Meteorology
- Scored in Top 10% of US Weather Forecasting competition among college undergrads / grads / professors and meteorology professionals
- Ocean passage from EssexCT to Annapolis

What makes Marine Weather Center unique?

- Forecasts by someone who has spent time on a small boat, for someone on a small boat.

- Forecasts include worst-plausible-solution, not most-likely solution.

Products

- Weather services (weather forecasts and routing advice)
- Useful books (Marine Weather book by Chris Parker, and Caribbean Weather book by David Jones)

Marine Weather Center Services

- High value-added weather forecasts and routing advice for sail and power vessels of all sizes
- Specialize in the Atlantic (Bahamas, Caribbean, US E Coast, Bermuda, Transatlantic)
- Also service Pacific, Indian, S Atlantic Oceans, Mediterranean
- Provide economical annual, monthly, or per trip plans/forecasts
- Regional Daily Email forecasts: all the information you should need for good weather-based decision making along US E Coast, Bahamas, and Caribbean ($55/mo to $199/yr).
- Custom weather forecasts and routing advice (for your vessel and itinerary) including departure planning, via SSB Voice Radio (anywhere within about 3000 miles of Florida) and Internet Webcasts (anywhere worldwide) ($99/mo or $199/yr).
- Custom weather forecasts and routing advice including departure planning, virtually worldwide, delivered by email, voice telephone and text message (including DeLorme InReach / Garmin Explorer) ($30-$65 per forecast or 10 Custom forecast credits $250).

7 main topics:

1. GulfStream
2. Drivers of wind
3. Weather forecast model skill, a bit about models, ensemble forecasts
4. NOAA weather resources
5. Forecasting & routing in terms of "Inflection Points" and "Decision Points"
6. Weather routing software
7. Weather patterns likely during A2B Race

7 main topics:

1. **GulfStream**

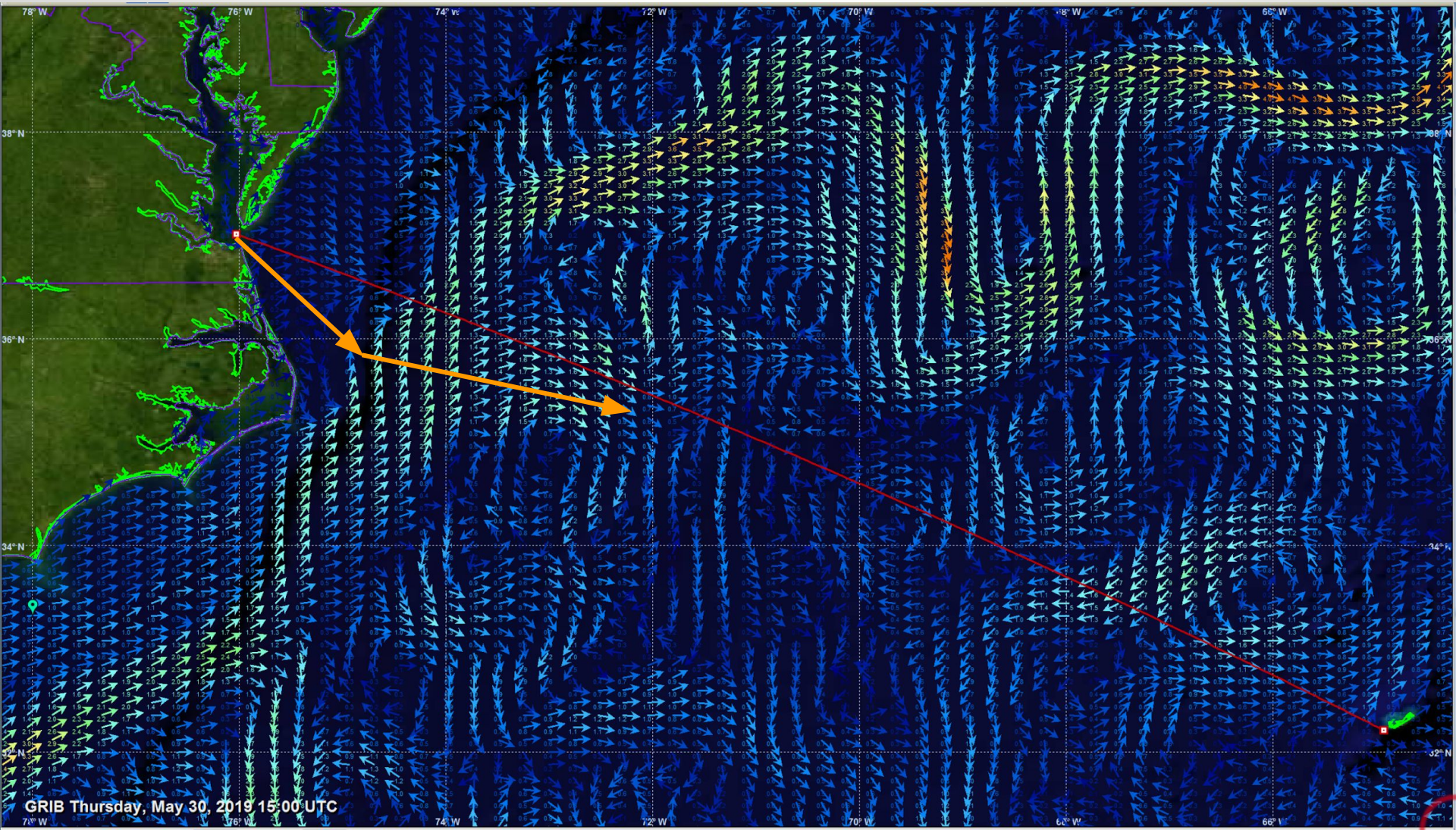
- Normal currents, and anomalies
- strategy: if any component of motion is adverse, then spend as little time in Stream by maximizing VMG perpendicular to Stream flow
- Computer models are improving, but, similar to weather models, have strengths / weaknesses:
- Size / strength of feature (models handle large, strong features well / small, weak features poorly)
- Dynamic / changing (models handle stable, uniform, consistent features well / unstable, chaotic, dynamic features poorly)
- forecast resources (Navy, HYCOM, RTOFS, Jenifer Clark, others)

Sea Surface Currents

- Don't ignore the weather
- Geostrophic currents versus tidal currents
- Jenifer Clark 2x/week
- Gridded vs Raster

Know what is "normal":

current flows NNE or NE from off Hatteras
E-flowing current S&E of Stream near 36N and also just S of 34N
Main GulfStream flows NE-ENE to 38N/70W



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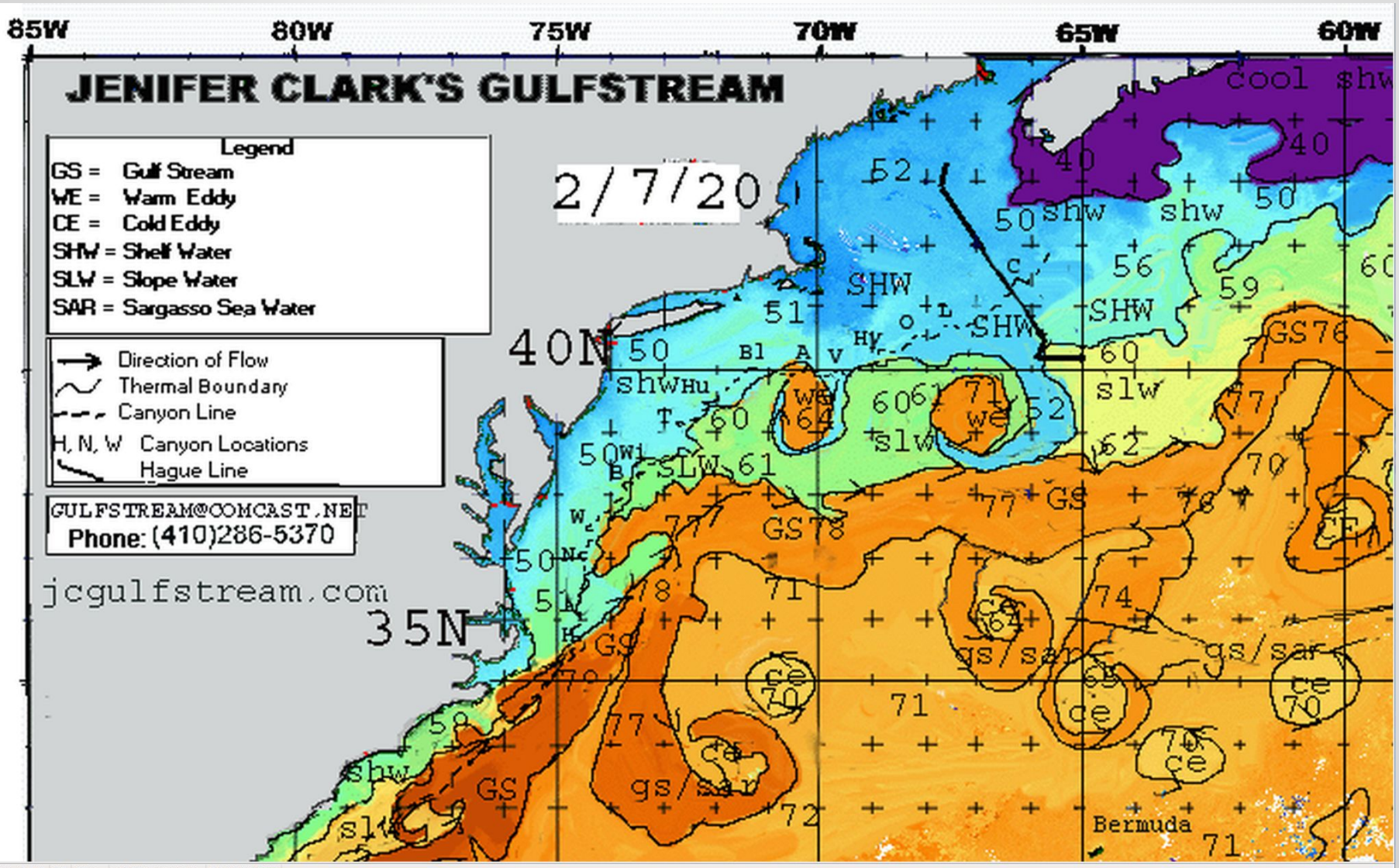
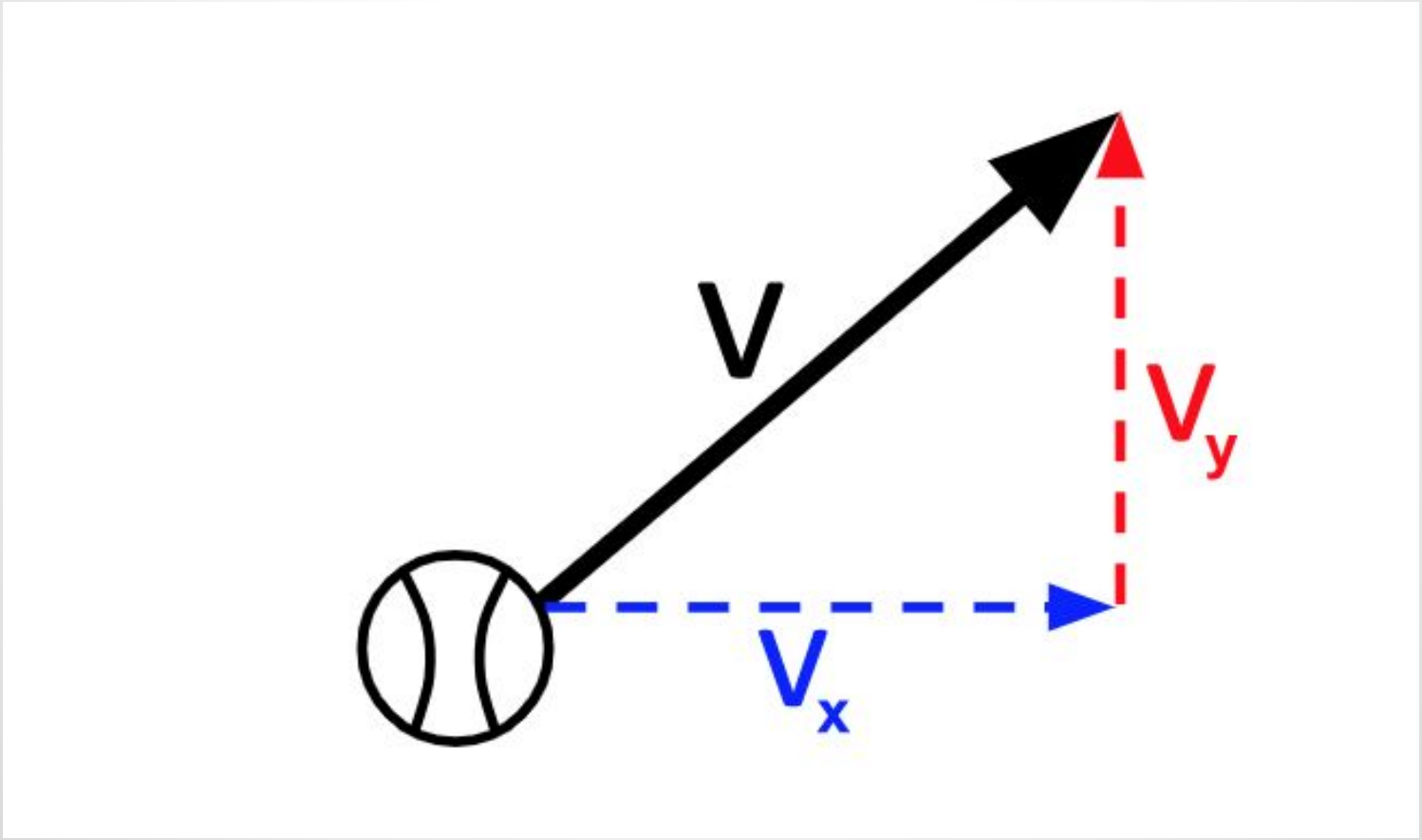


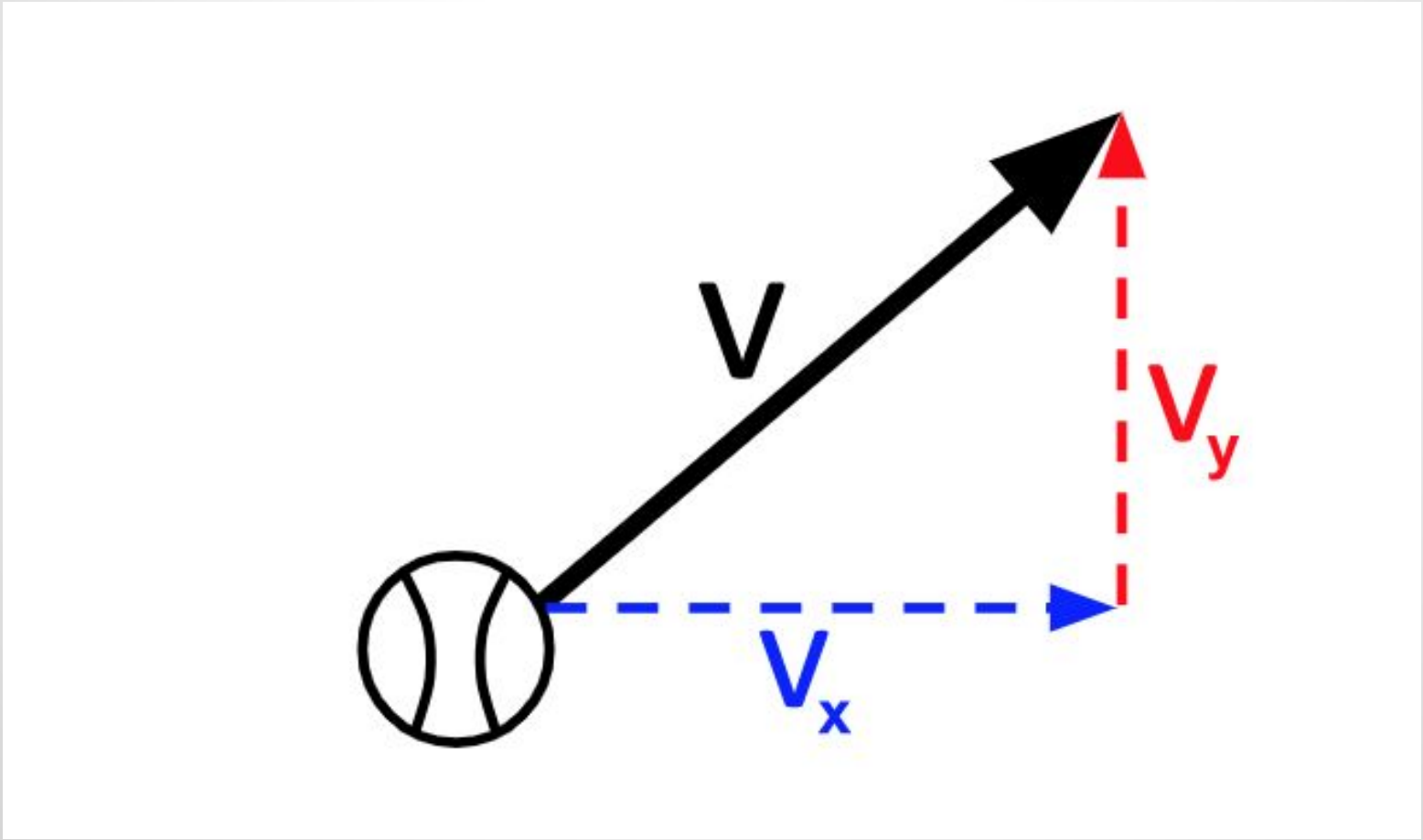
Components / vectors of motion

If you are traveling NE, then there is a N-component to your motion, as well as an E-component



Components / vectors of motion

Simple geometry (the sine of the angle) tells us how much of our forward speed is made in each component direction.

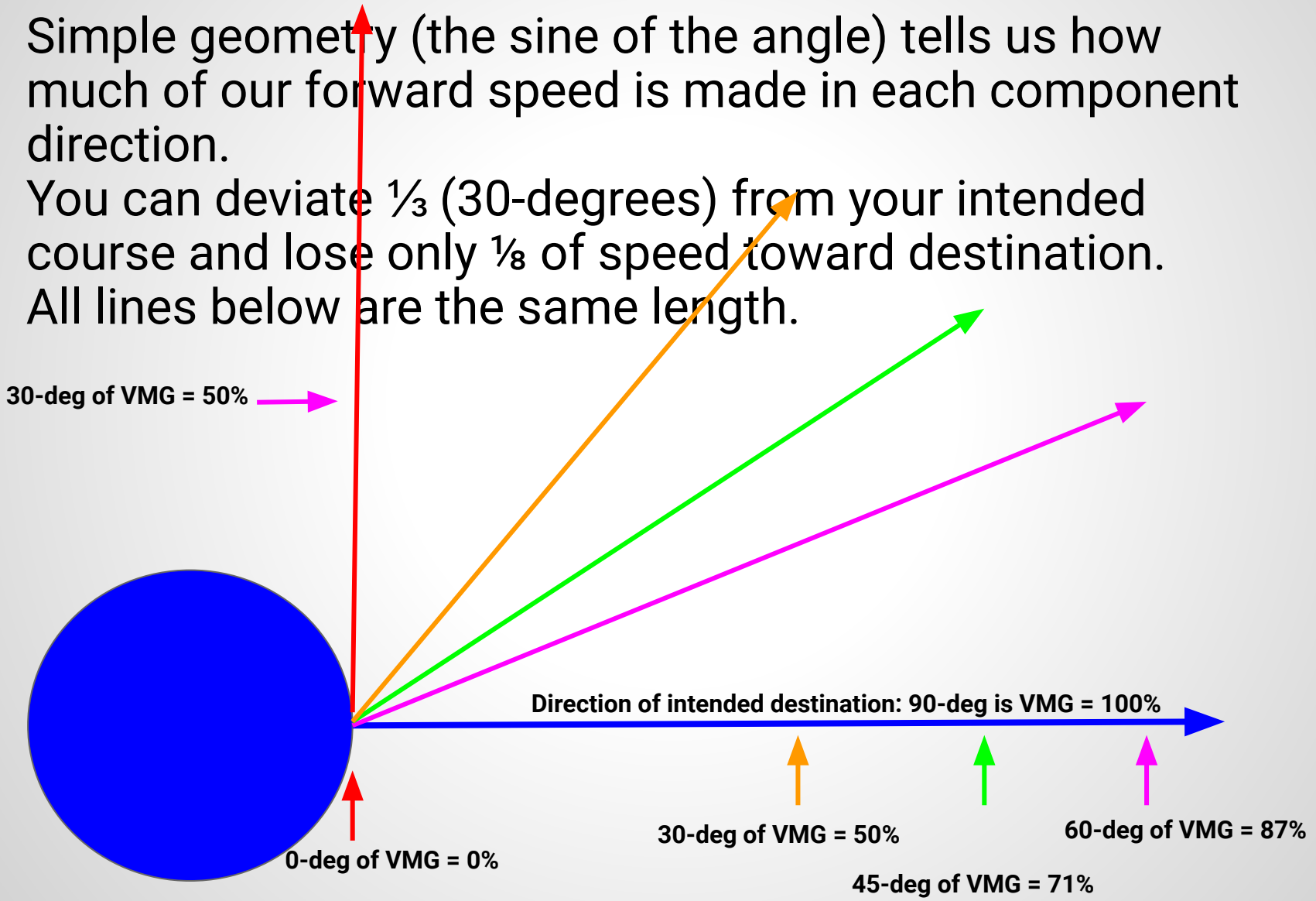


VMG = Velocity Made Good (component of motion toward intended destination)

Simple geometry (the sine of the angle) tells us how much of our forward speed is made in each component direction.

You can deviate ⅓ (30-degrees) from your intended course and lose only ⅛ of speed toward destination.

All lines below are the same length.



7 main topics:

1. GulfStream
2. **Drivers of wind**

   --Large scale pressure gradient

   --Convection

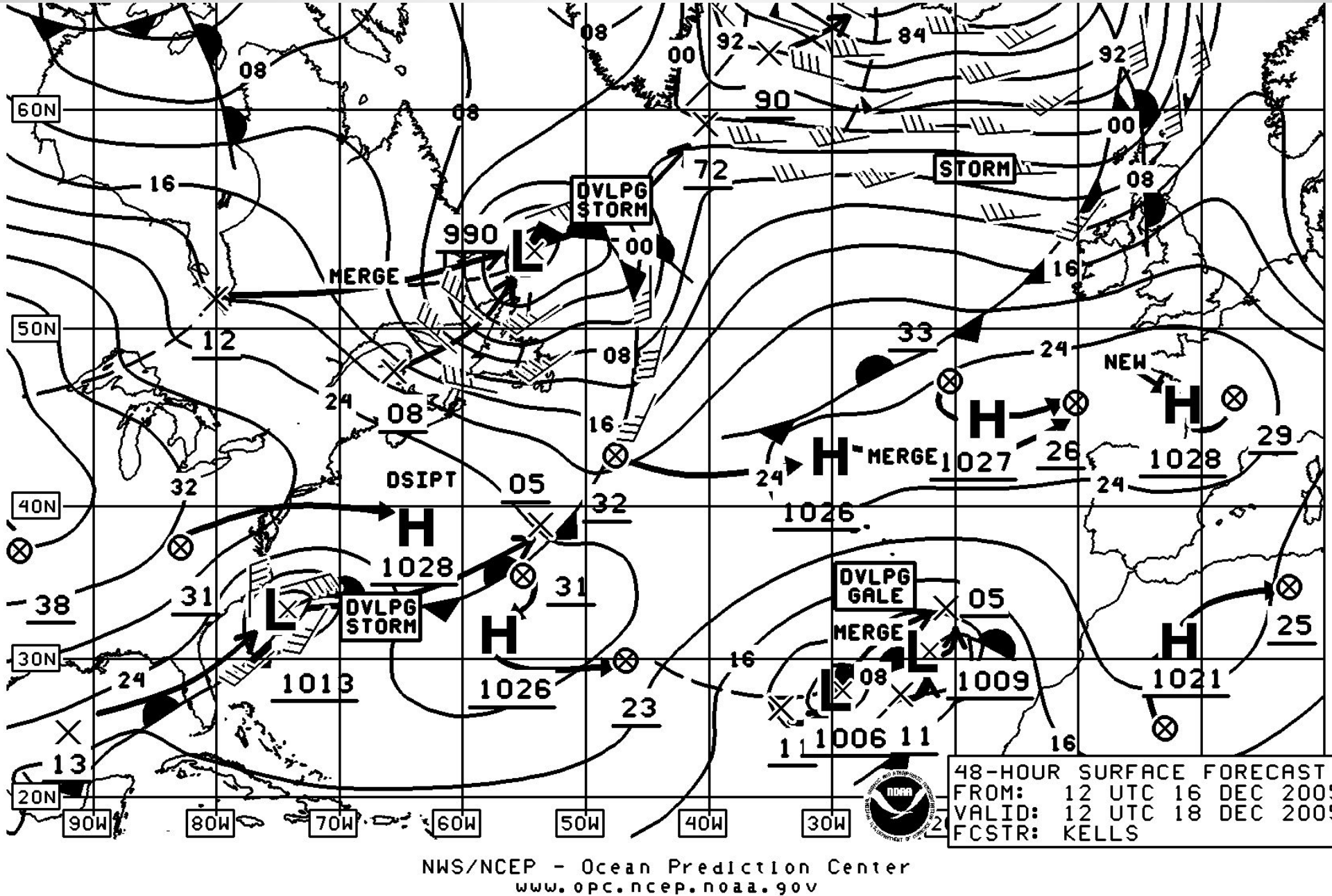
   --Boundary Layer Effects

WIND	Gradient	Convective	Boundary-Layer
Driver	Pressure drop over distance (specifically air flowing from high pressure to low pressure)	Thermal differences within airmass (specifically parcels of air which are warmer than airmass rise, other parcels may fall)	Dis-uniformities driven by non-atmospheric phenomena (for example, friction differences between land and water / temperature differences of cool land versus adjacent warm water)
Direction	Horizontal	Vertical (up and, consequently, down)	Various, depending on nature of the dis-uniformity
Scale	Large / Synoptic (often 1000+ miles)	Small (from tens of feet to a few miles), but predisposition may be meso-scale (hundreds of miles)	Local, exact size depends on the dis-uniformity (from few feet to 100+ miles)
Variability	Wind is steady in direction/velocity	Convection causes wind direction/velocity to vary	Influence on direction/velocity of wind varies, reflects the dis-uniformity
Predictability Confidence	Computer models and many forecasters provide accurate, high-confidence forecasts	I attempt to quantify potential forecast details, but most forecasts don't. Coverage, persistence and intensity difficult to quantify, but combination of LI and/or CAPE and quantity of precipitation are clues for guess-timates	Some computer models and other forecasts attempt to include, but effects may be too-small (geographical coverage), too-shallow (just near ground), too-short duration for most models and forecasts to include. I typically address these issues vessel-by-vessel only, as precise timing & location are key
Surface Effects	Steady, sustained wind +/- 20% in gusts/lulls	Significant velocity and/or direction change, intermittent/periodic, lasting from seconds to minutes, but predisposition may persist hours	Significant velocity and/or direction change, proportional to the dis-uniformity causing the boundary-layer effect
Persistence	Persistent	Brief for individual cells, but predisposition may persist hours in a general area	Depends on dis-uniformity - once established, generally persists until trigger ends

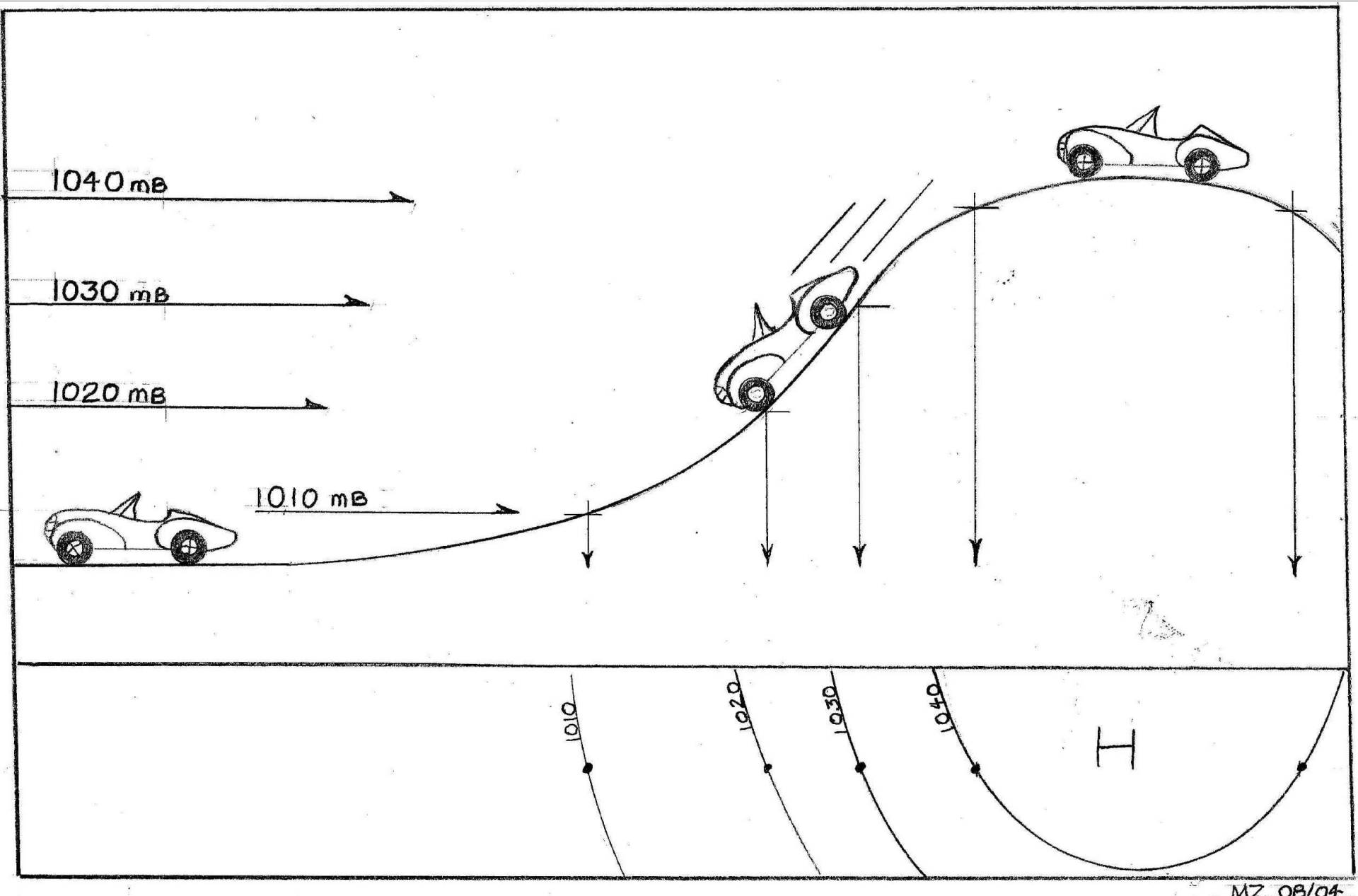
IMPORTANT CONCEPT:
“Gradient Wind”

Large-scale wind is driven by pressure gradient (difference in pressure over distance).

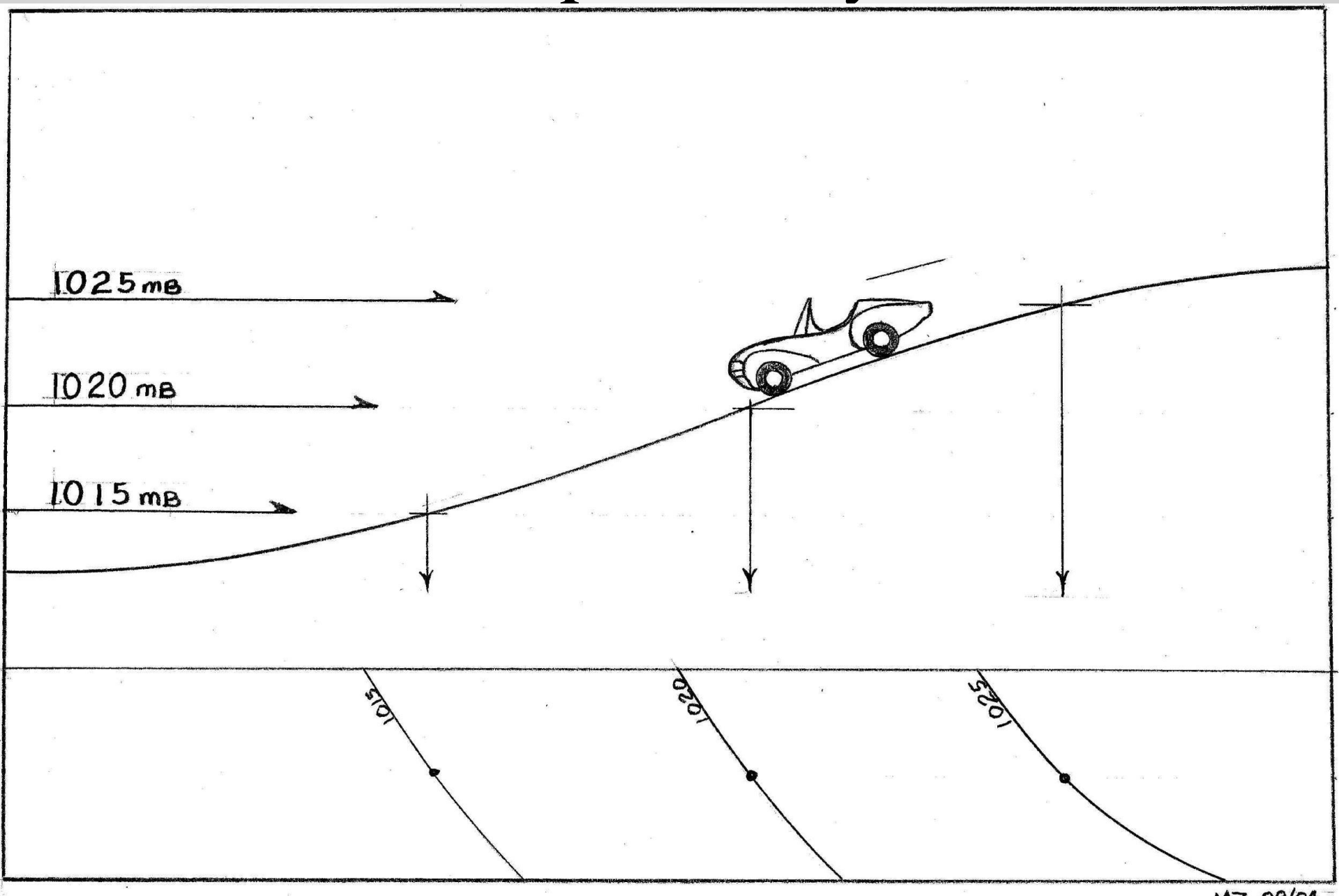
Isobar: *iso* = same, *bar* = pressure



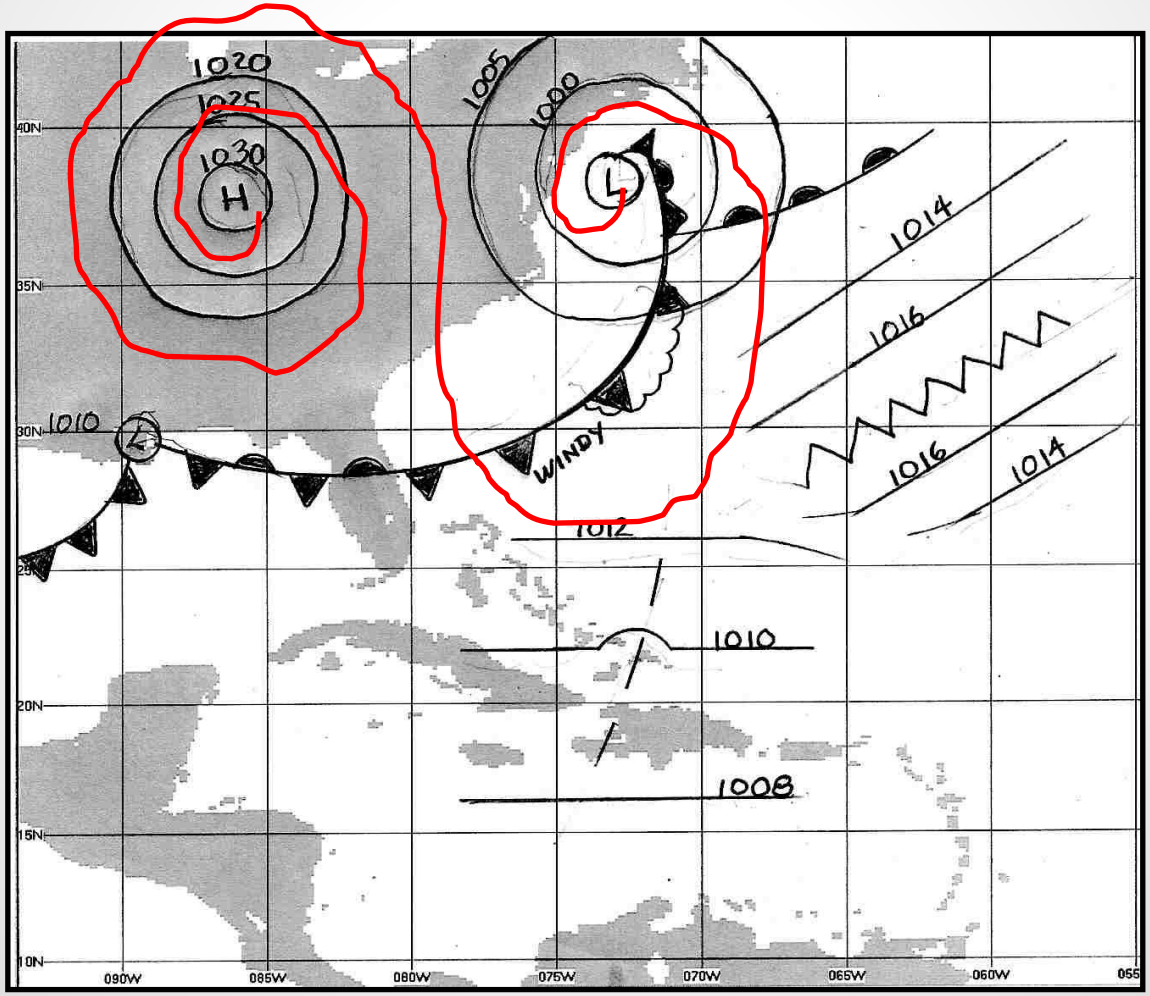
"HI" pressure system



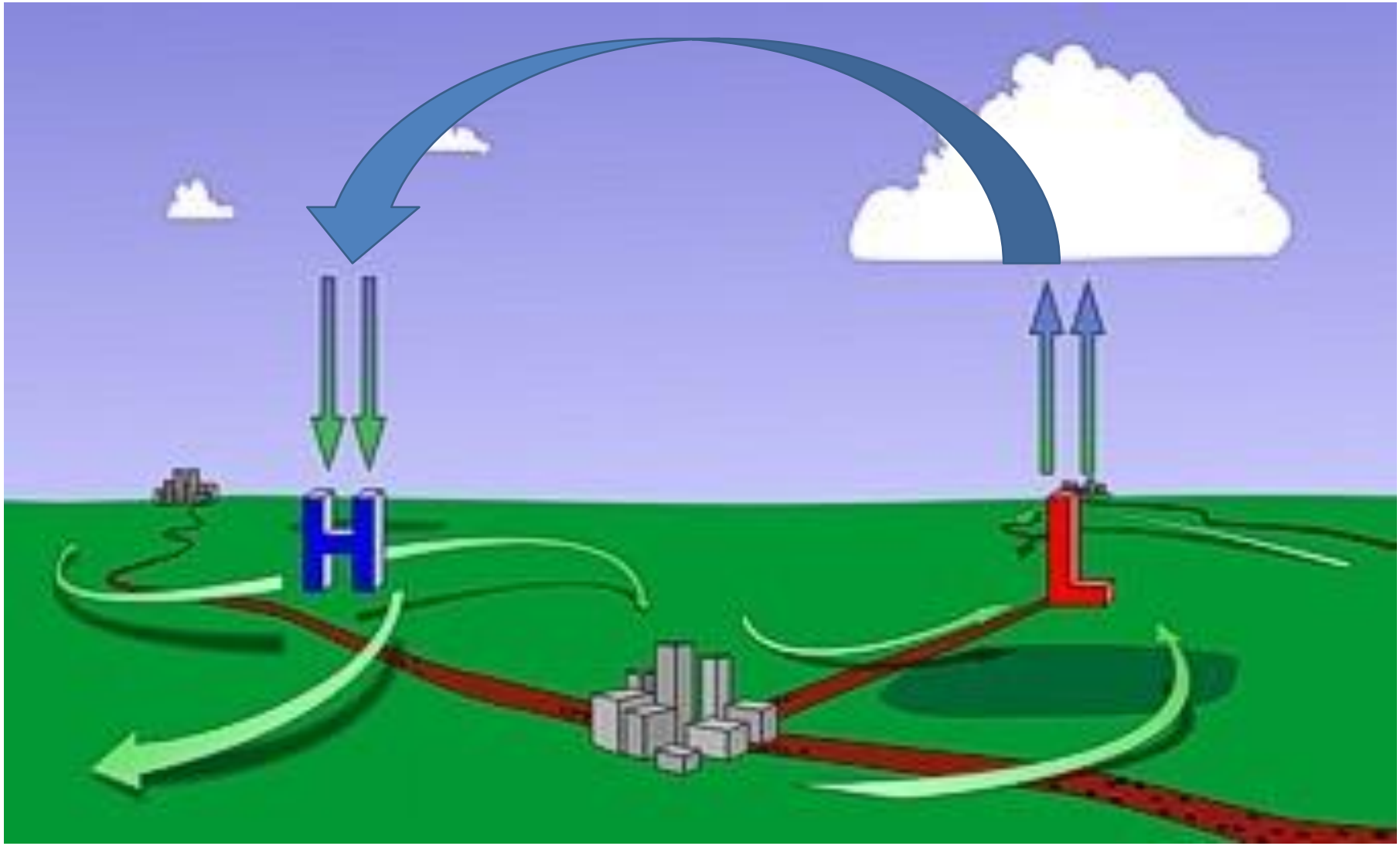
"RIDGE" pressure system



Due to spin of the Earth, air spirals outward from a HI and spirals into a LO...and flow in this diagram neatly represents the veering of wind ahead of a LO and its ColdFRONT.
Also, air coming from HI is heavy dry sinking air / air moving into LO is light moist rising air.



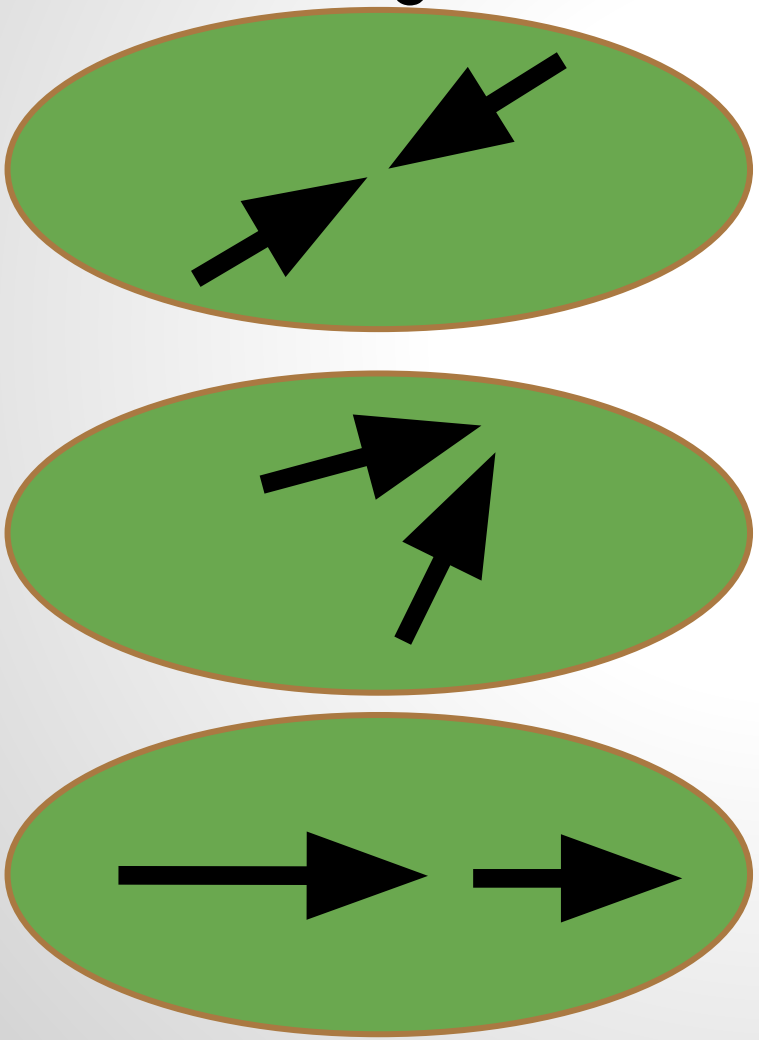
Energy Transfer, ***Synoptic***



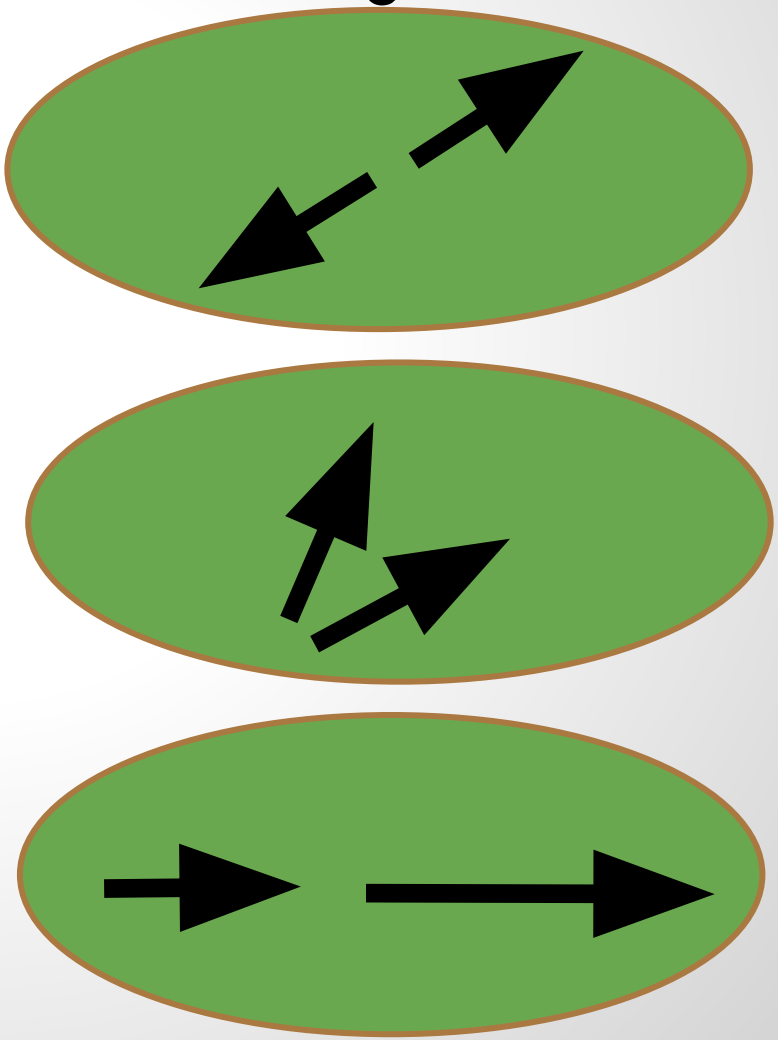
Convergence and Divergence

- Airflow which is coming together is termed **convergence**
- Airflow which is moving apart is termed **divergence**

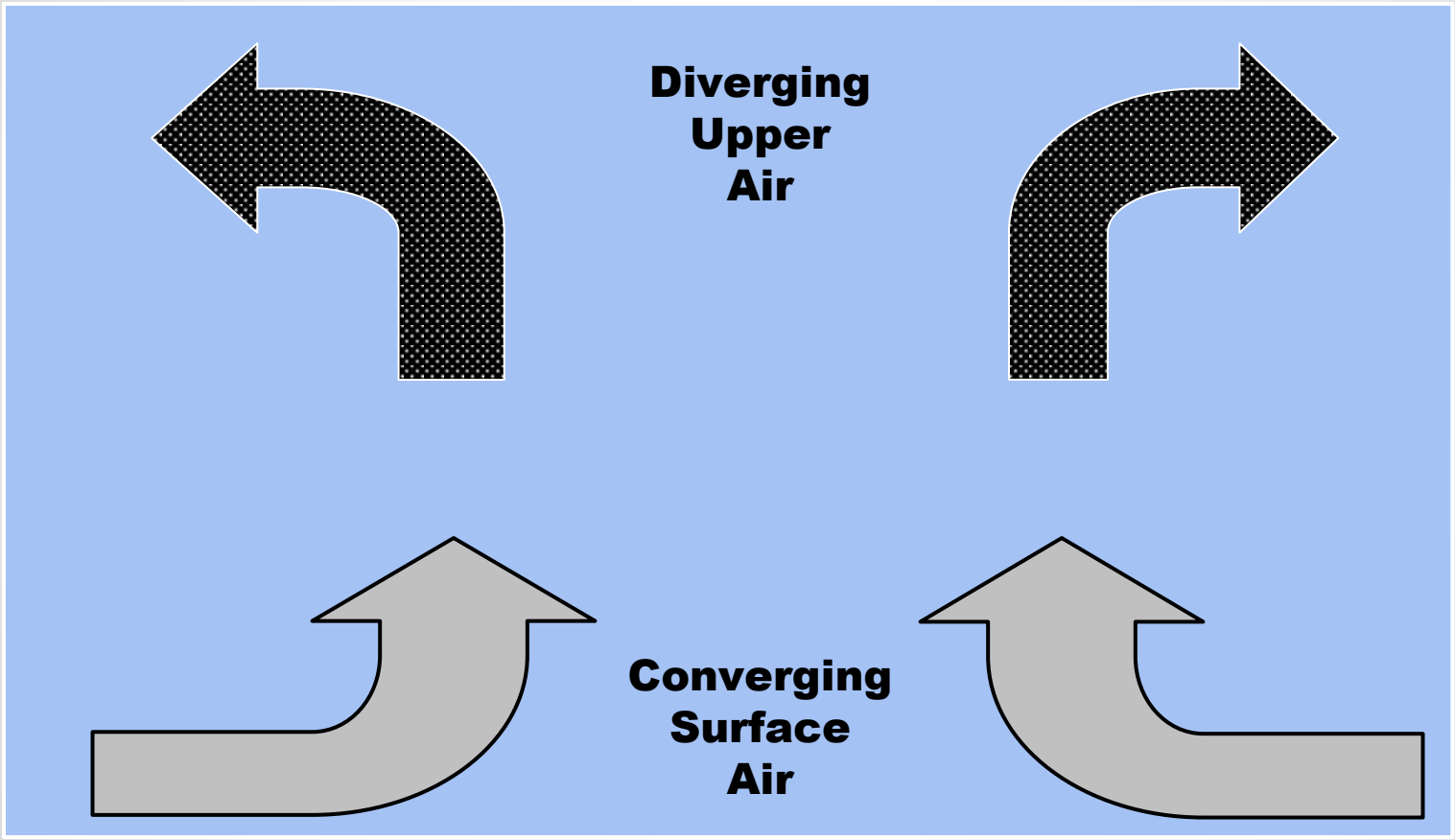
Convergence



Divergence



All you need to know about 500mb / upper-air weather



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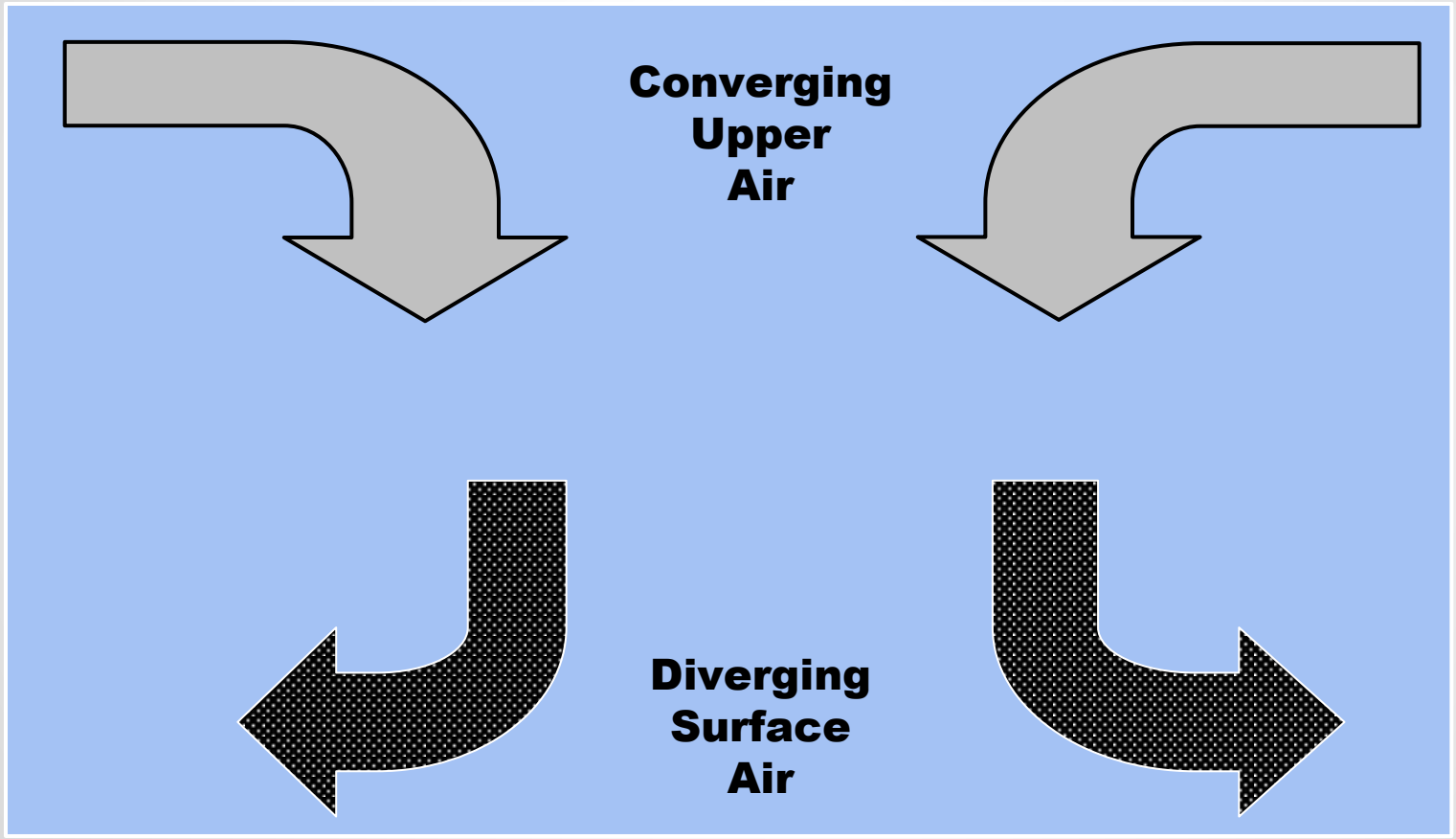
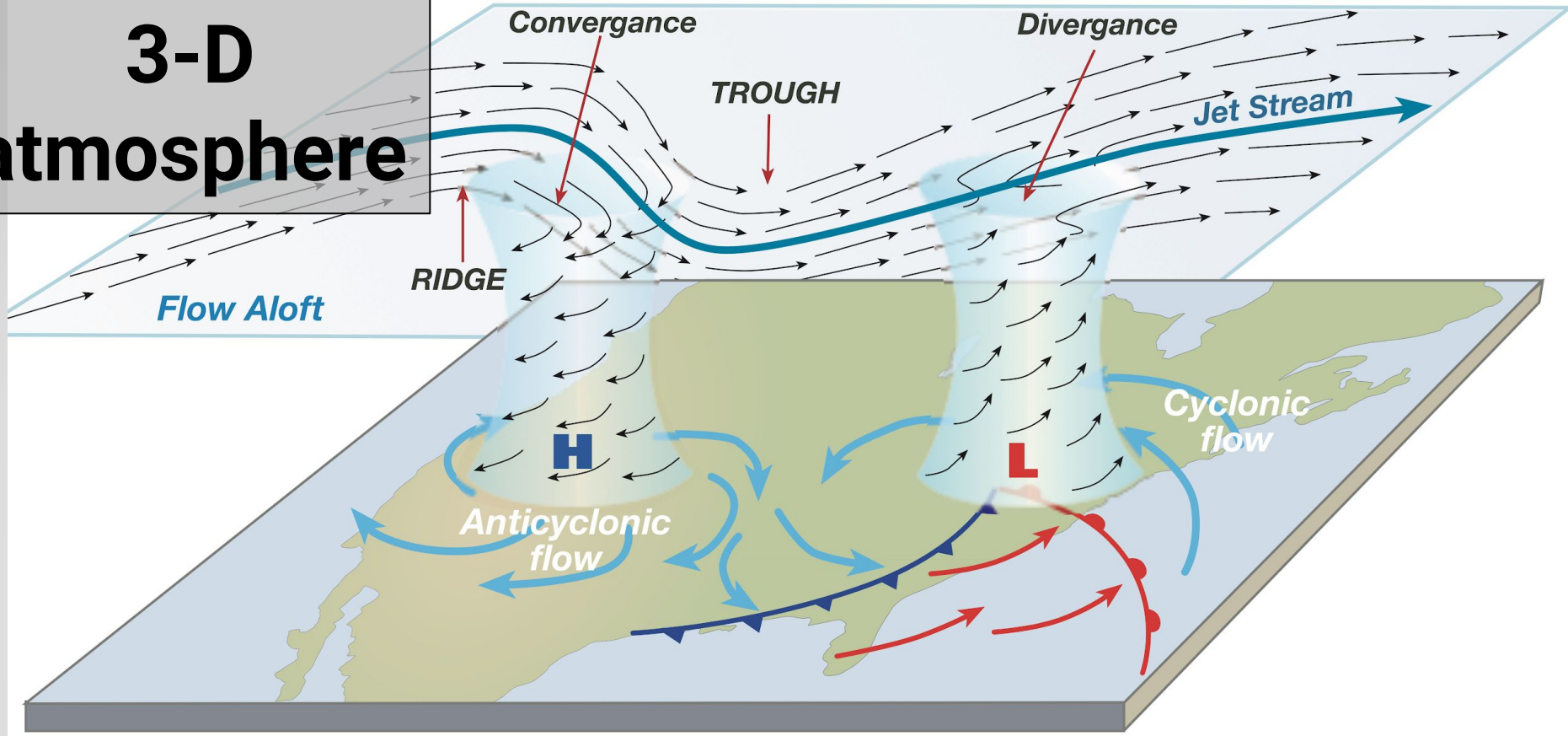


3-D atmosphere



- **Upper-Convergence** E of upper-RIDGE causes a traffic jam of molecules aloft, increasing weight in this column of air, inducing a downward motion of air molecules.
- At the surface, this creates **Surface-Divergence** - downward-moving molecules convert downward vertical momentum into outward horizontal motion.
- Characteristics of HI pressure system = **air spirals downward and outward in a clockwise rotation**. This air tends to be dry, and low-energy (when behind a ColdFRONT this air can be very cold, but with no FRONT it may be hot, dry air).
- **Upper-Divergence** causes more space between air molecules, and a net acceleration of molecules.
- At the surface, this creates lower surface pressures, allowing air to rise, and **Surface-Convergence** of surface molecules rushing inward to replace rising molecules.
- Characteristics of LO pressure system = **air spirals inward-and-upward in a counter-clockwise-rotation**. Warm and (especially in marine environments) moist, packs lots of heat and latent (potential) heat.

Drivers of Convective Wind

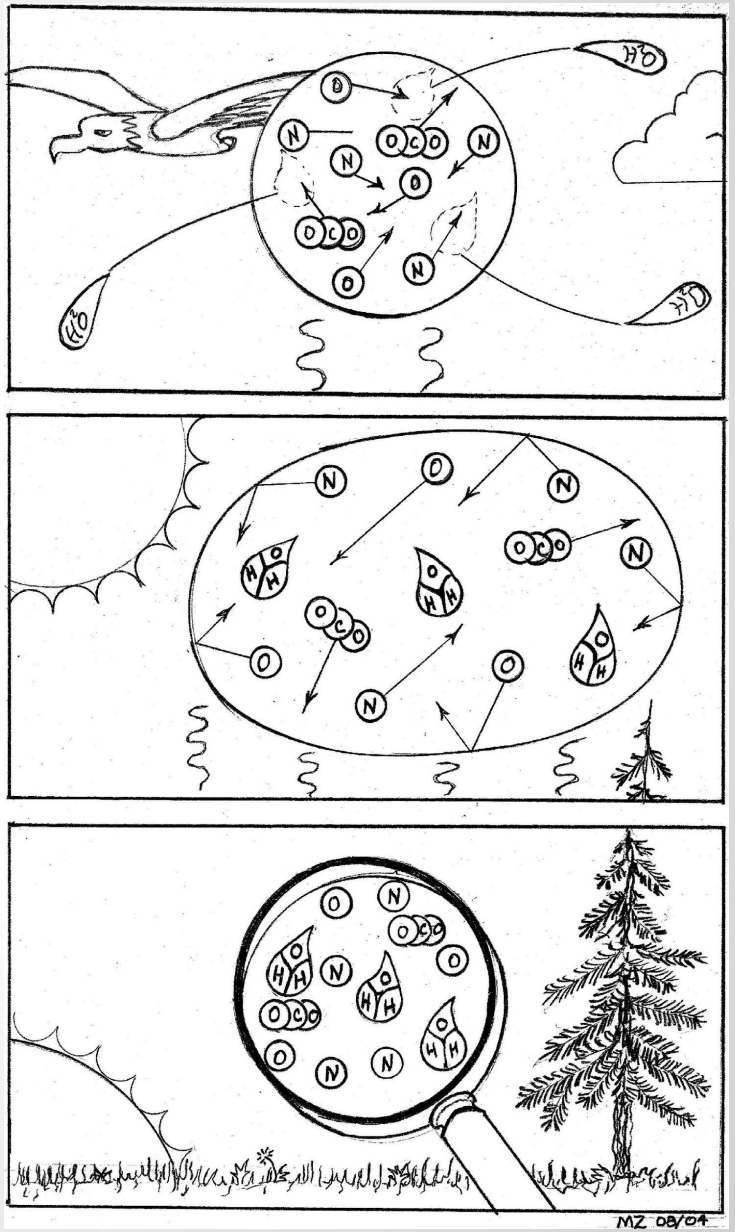
- In general, Weather is Earth’s mechanism to redistribute atmospheric energy.
- With convective (thermal) wind, warm air rises
- so, Air moves vertically as well as horizontally
- Moisture = potential (latent) energy
- Rising moist air moves potential energy up in atmosphere (from where it can later come crashing down)
- Energy equalization occurs on many different scales
- Let's explore small scale energy transfer as well as big picture (global energy transfer)

Hot Air Rises, Transporting Energy (sensible heat and latent heat in the form of water vapor) Upward

3. As our warm parcel rises, it cools, but surrounding airmass also cools - our parcel continues rising as long as it remains warmer than the surrounding airmass. At some point our parcel may cool to such an extent that it can no longer hold all its water in vapor form. When this happens, water vapor begins condensing into water droplets. Condensation of water vapor is "exothermic" - releasing heat into our parcel of air, keeping parcel **warmer** than airmass, so it continues rising. This can lead to towering thunderstorms capable of strong downbursts.

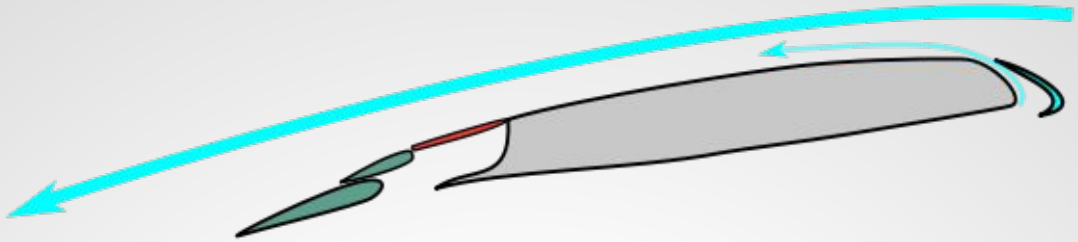
2. As morning progresses, sun heats ground unevenly, creating parcels of warmer air (warmer than surrounding airmass). Molecules in our warmer parcels are bouncing around lively, expanding, and high energy. All water is in vapor form.

1. Examine parcel of air molecules. Early in morning air molecules are cool, compact, and low-energy. Water is in vapor form, with some water droplets if foggy.

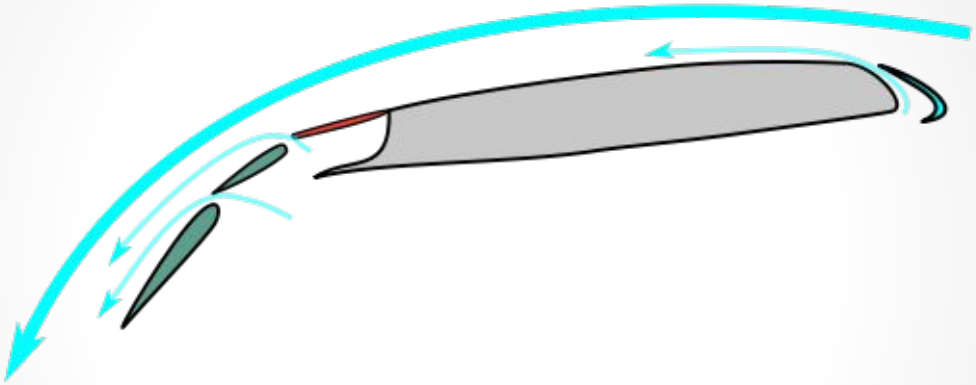


Boundary Layer Effects

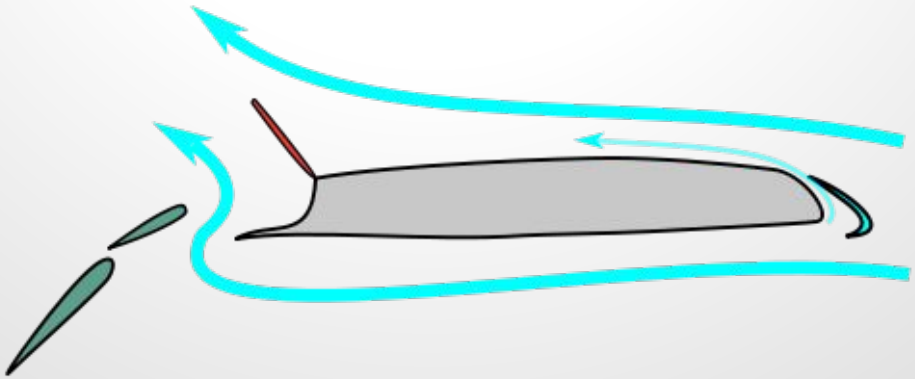
- Wind tends to parallel Coasts, and stronger than gradient wind forecast, due, in part, to funneling & less friction over water.
- Examples: SE US Coast / Florida / DomRep / W Cuba / Colombia.
- Greg mentioned local effects near Bermuda.

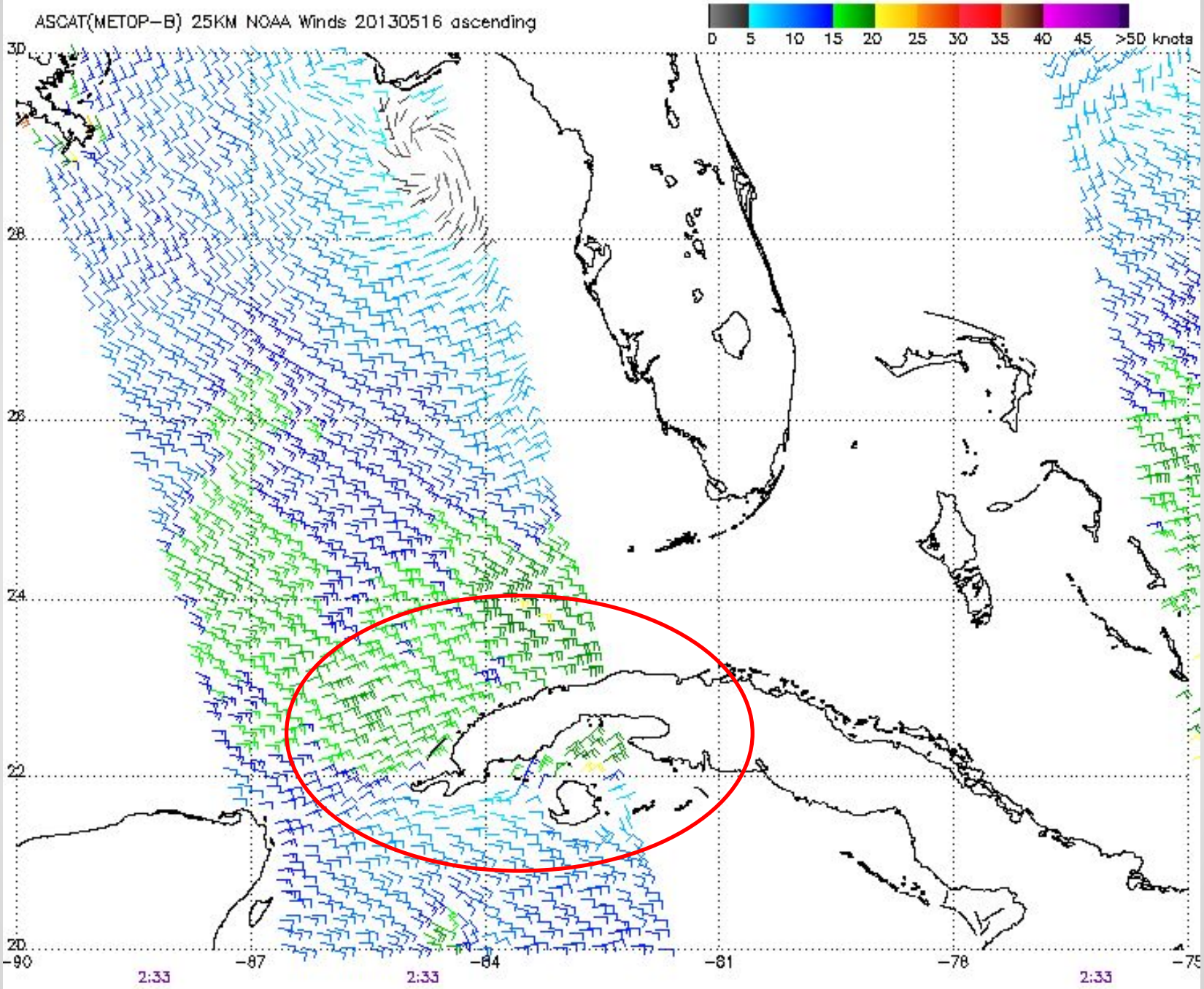


Maximum lift and high drag – approach to landing



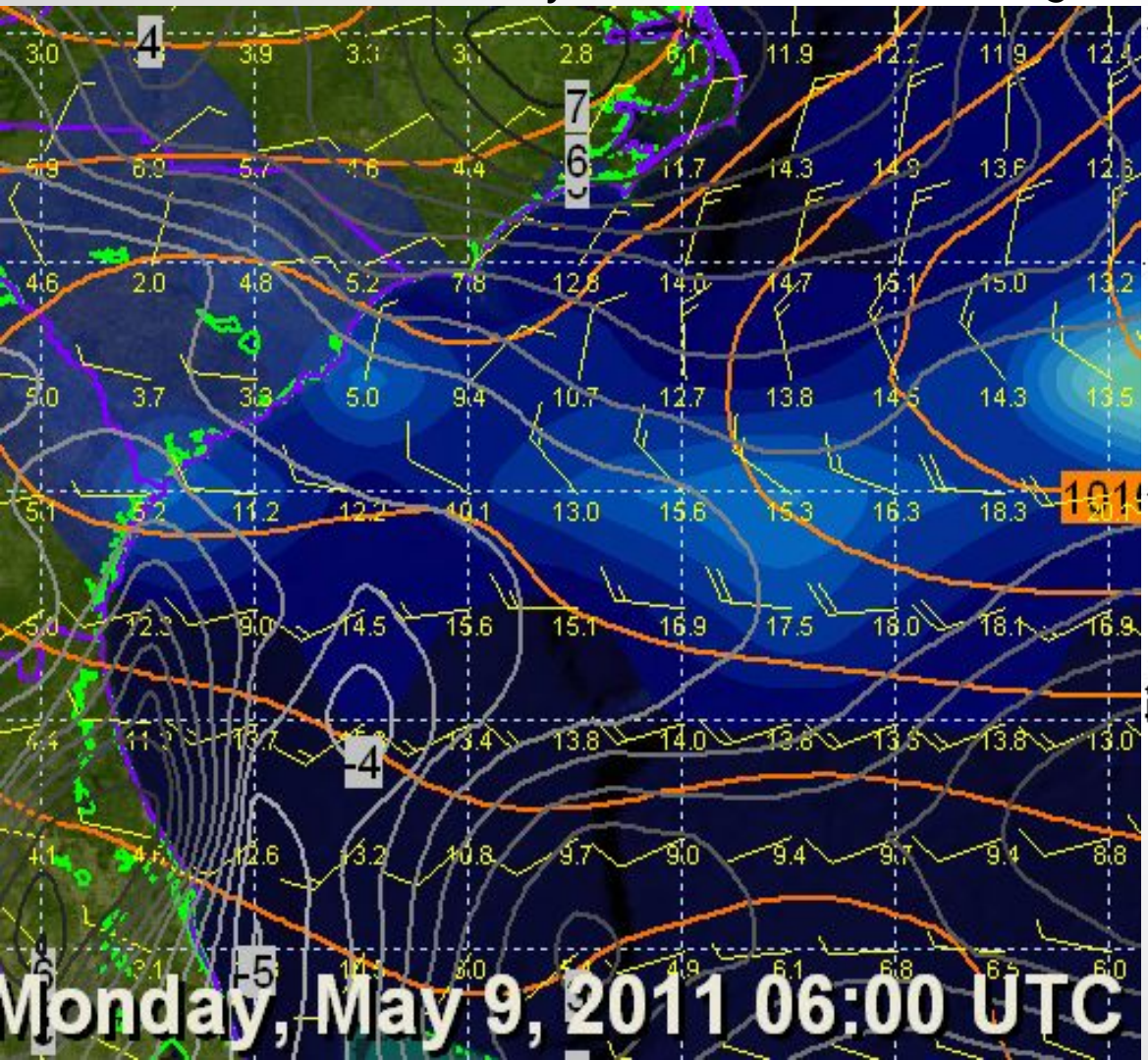
Maximum drag and reduced lift – for braking on runway

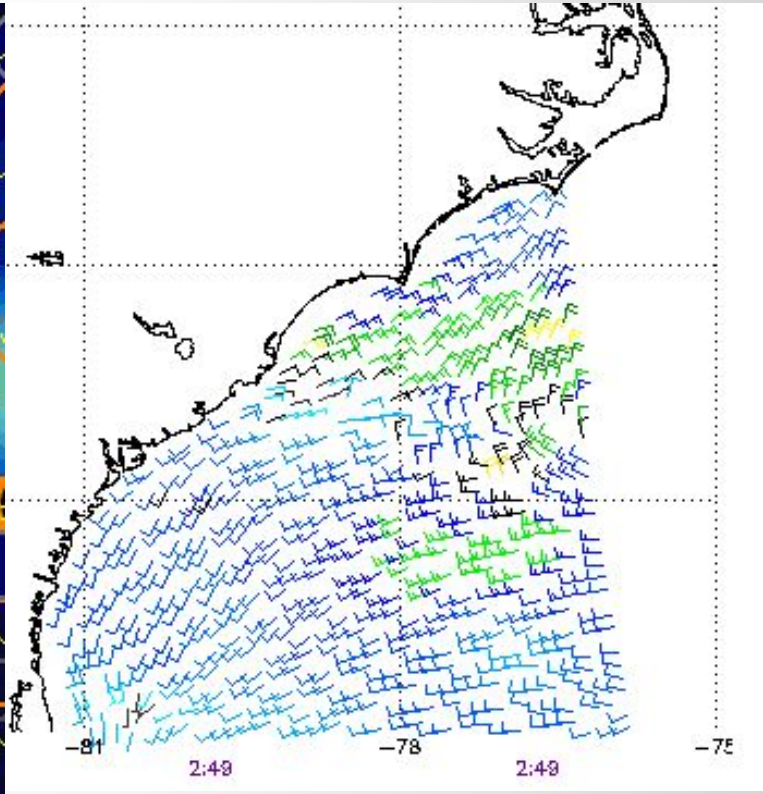



ASCAT(METOP-B) 25KM NOAA Winds 20130516 ascending
0 5 10 15 20 25 30 35 40 45 >50 knots
30
28
26
24
22
20
-90
-87
-84
-81
-78
-75
2:33
2:33
2:33
Note: 1) Times are GMT 2)Times along bottom correspond to measurement at 25N
3)Data buffer is 22 hrs from 20130516 4) Black circles indicate possible contamination
NOAA/NESDIS/Office of Research and Applications

Wind parallels Coast

Wind tends to parallel Coast, and often “funnels”, stronger than forecast.
Below, Near-Shore forecast (left) is for W@12 ahead of FRONT / N@5-10 just behind FRONT / NNE-NE@7-14 from FryingPanShoal to Hatteras.
Actual conditions? Only WSW & ENE wind along Coast, with 13-22k N of FRONT.





7 main topics:

1. GulfStream
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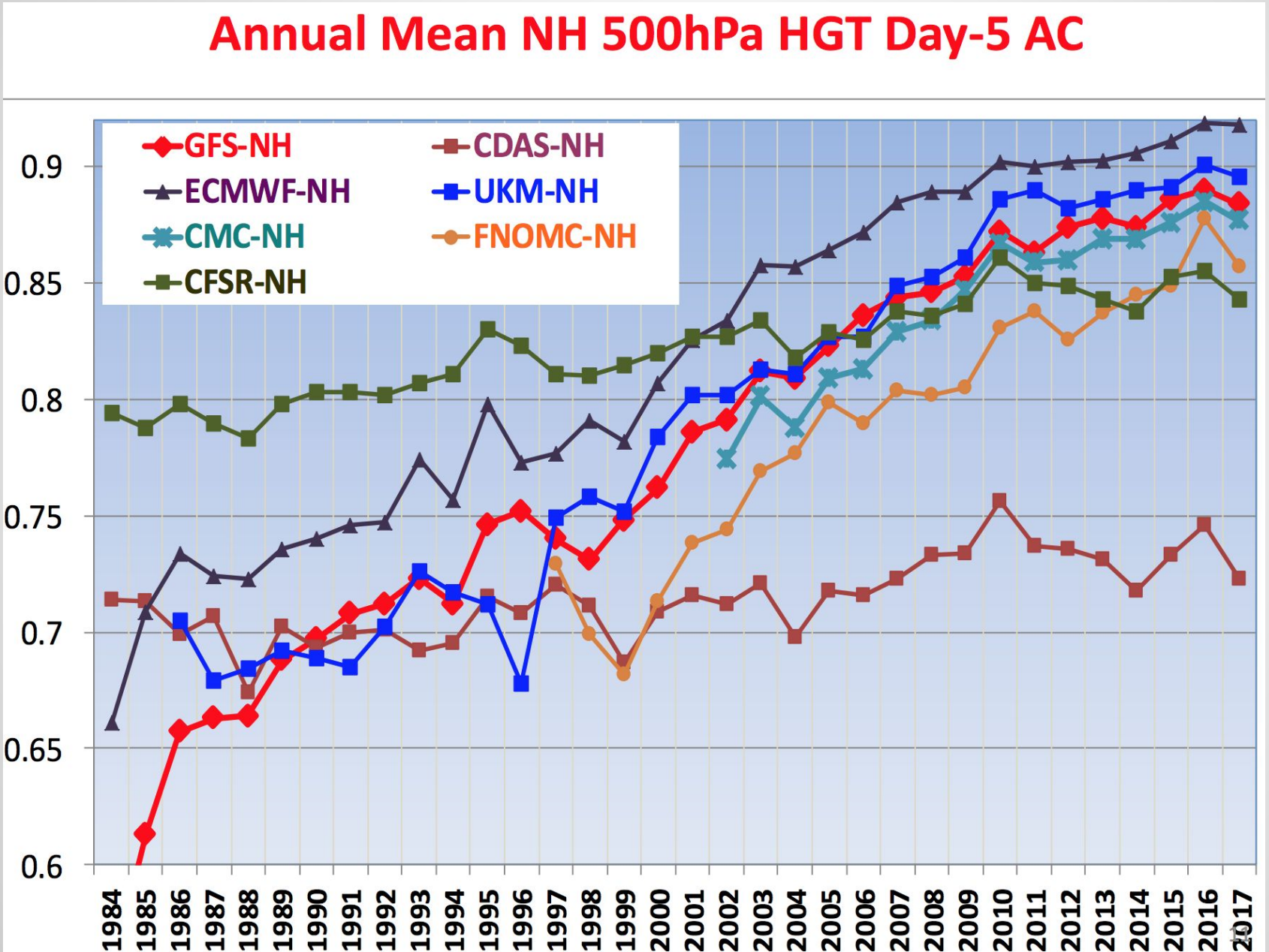
Long-range forecasts

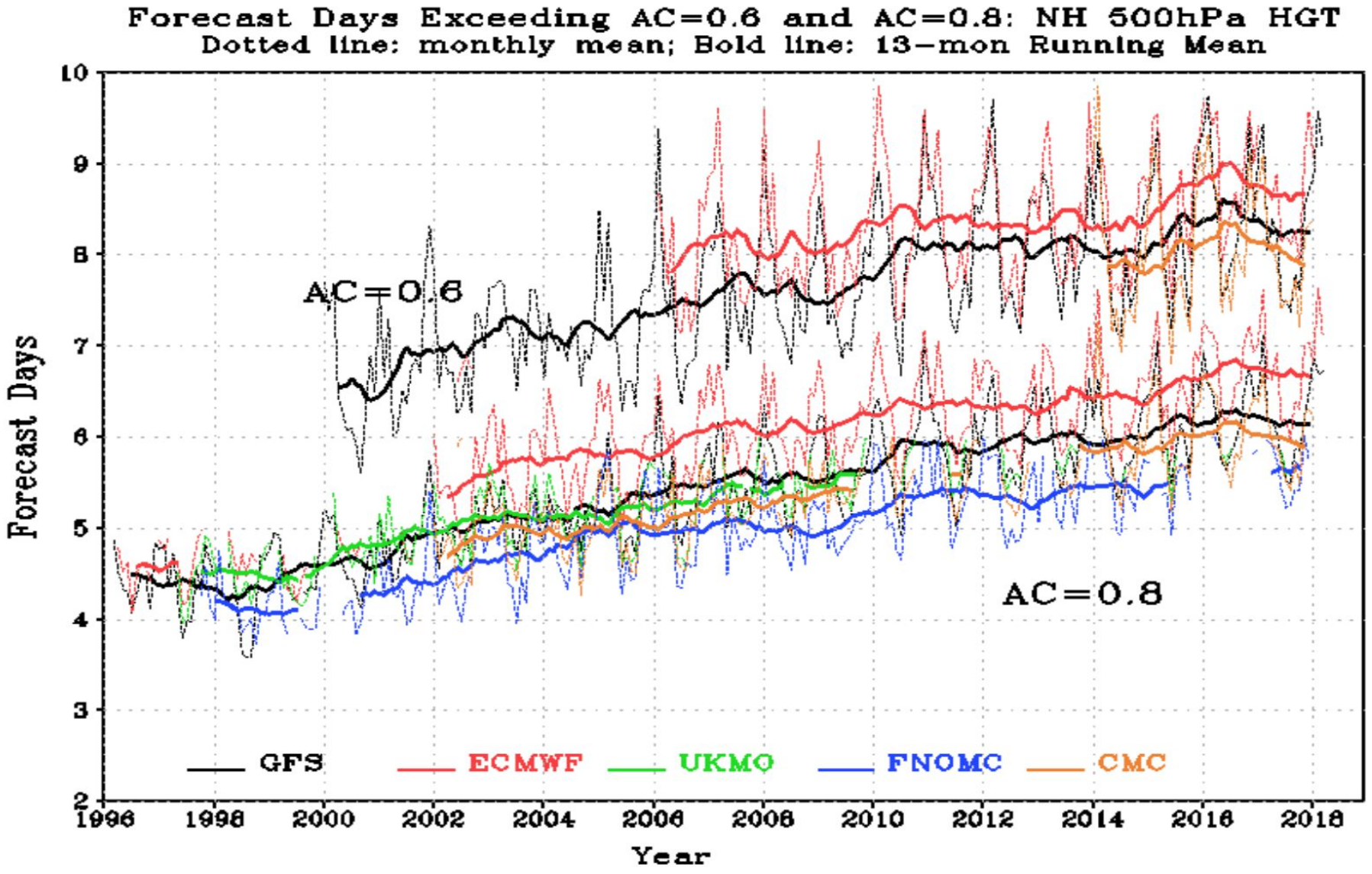
- Forecasts in general, and Operational forecast models in particular continue improving.
- Model selection is important - of the major Global models run by government agencies, ECMWF (EURO) model is #1, UKMet #2, GFS #3.
- Next 5 slides show some interesting skill statistics.

Model Accuracy: improving over time - 5-day forecast accuracy for 500mb height

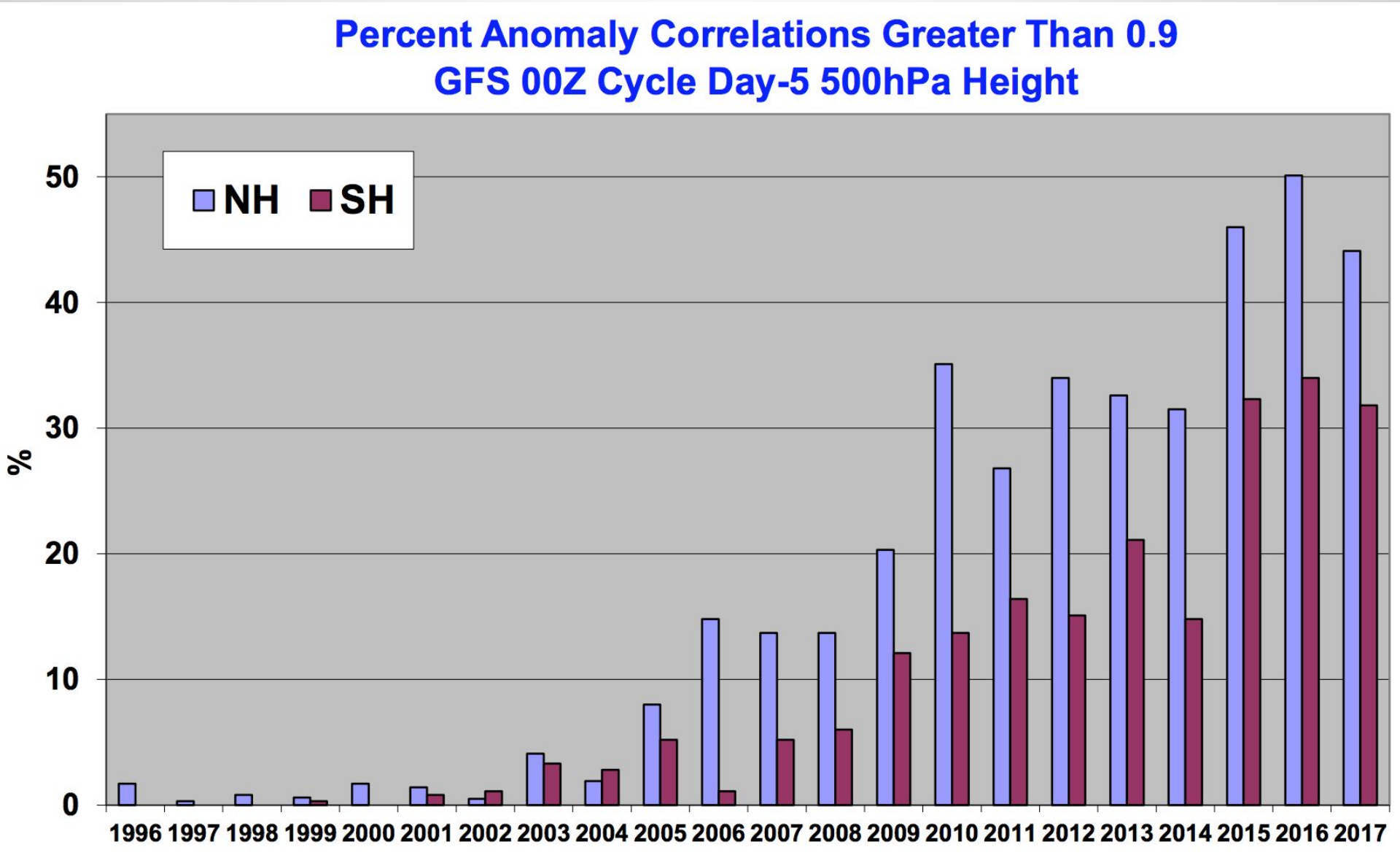


60% accuracy: 8.5-9.0 days EURO / 8.0-8.5 days GFS
80% accuracy: 6.5 days EURO / 6.0 days GFS & UKMet

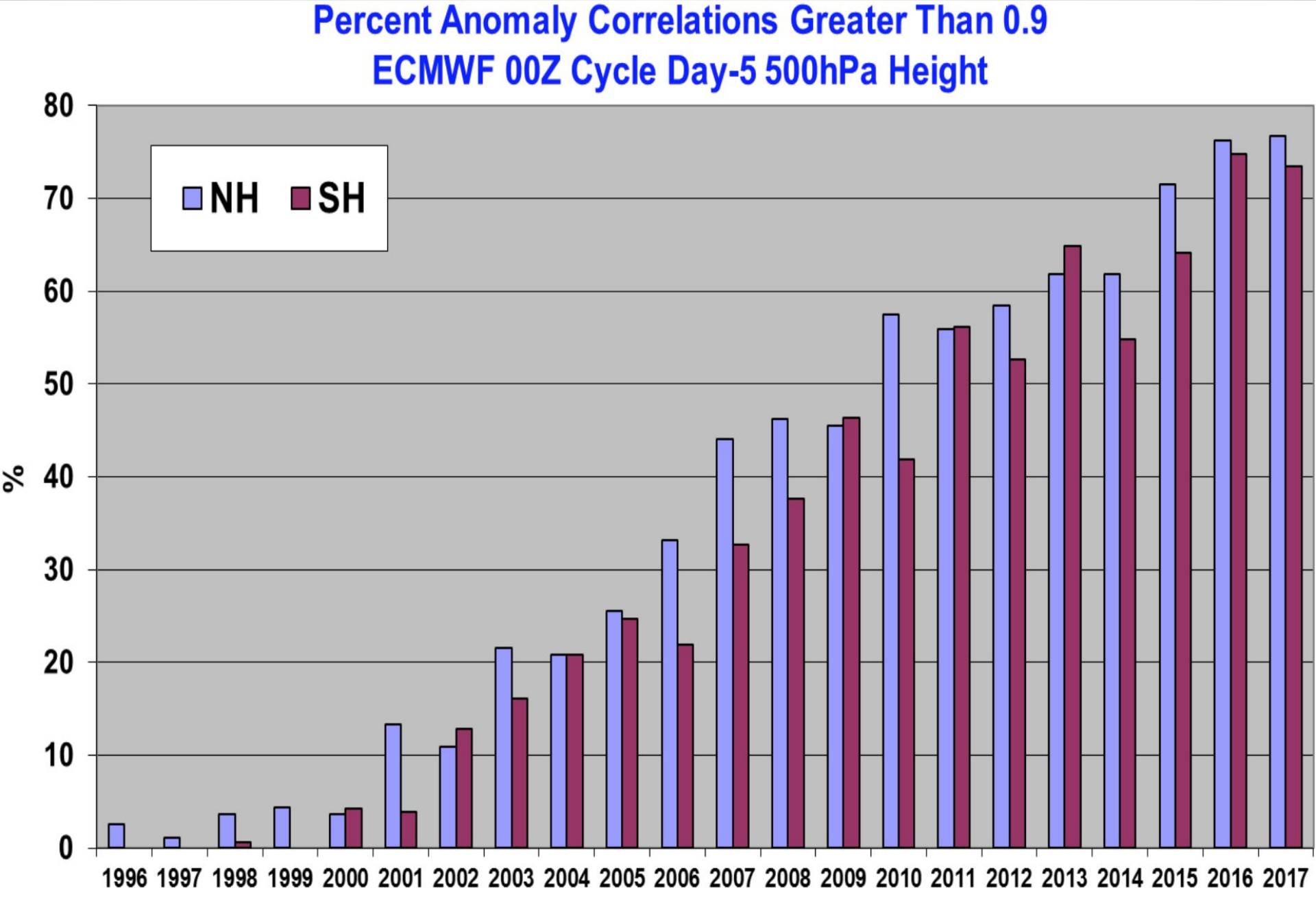
Useful Forecast Days for Major NWP Models, NH



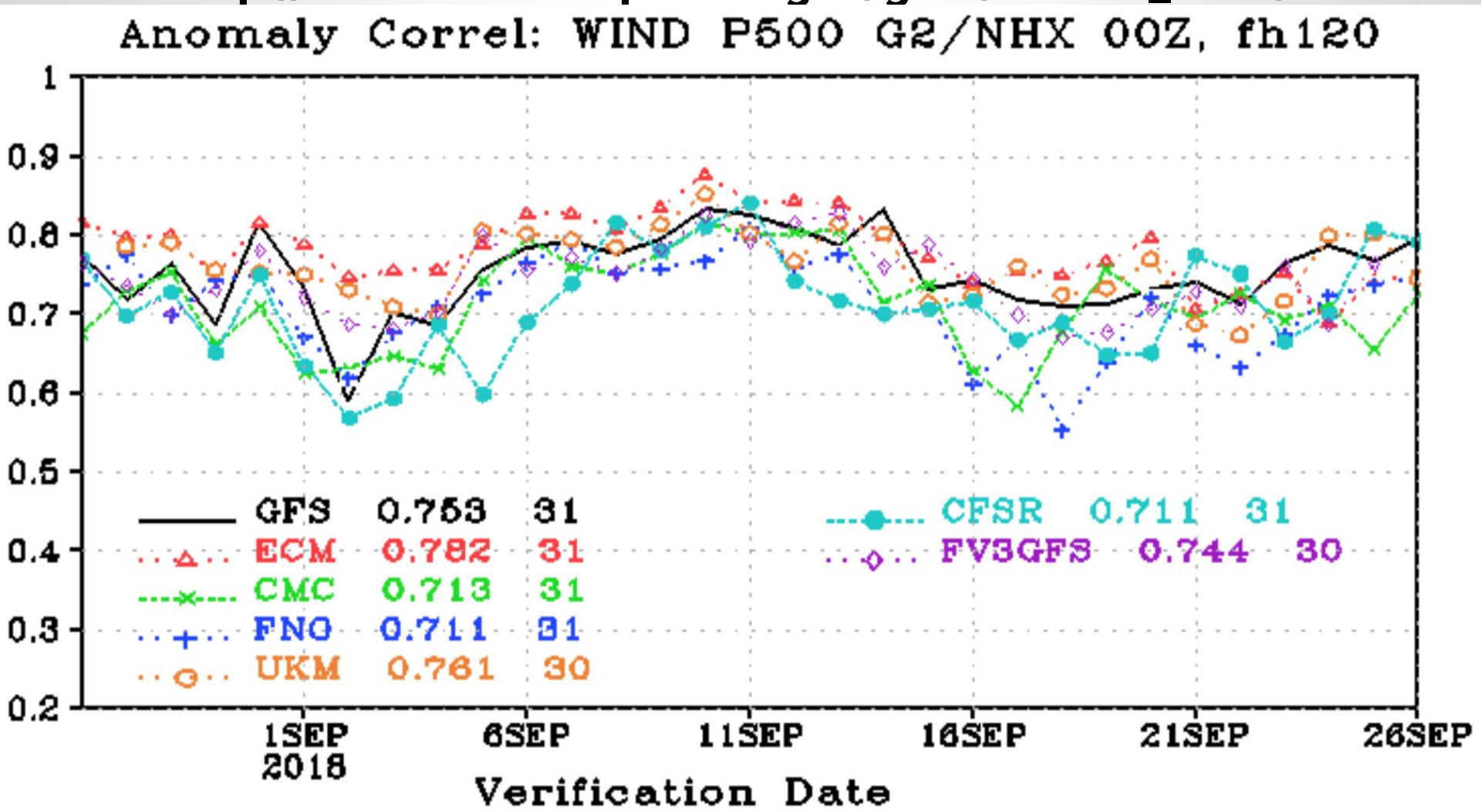
GFS 500mb height Day-5 forecasts are 90%+ accurate almost ½ the time now, versus ⅓ of the time before 2015, and less than ⅛ the time before 2010.



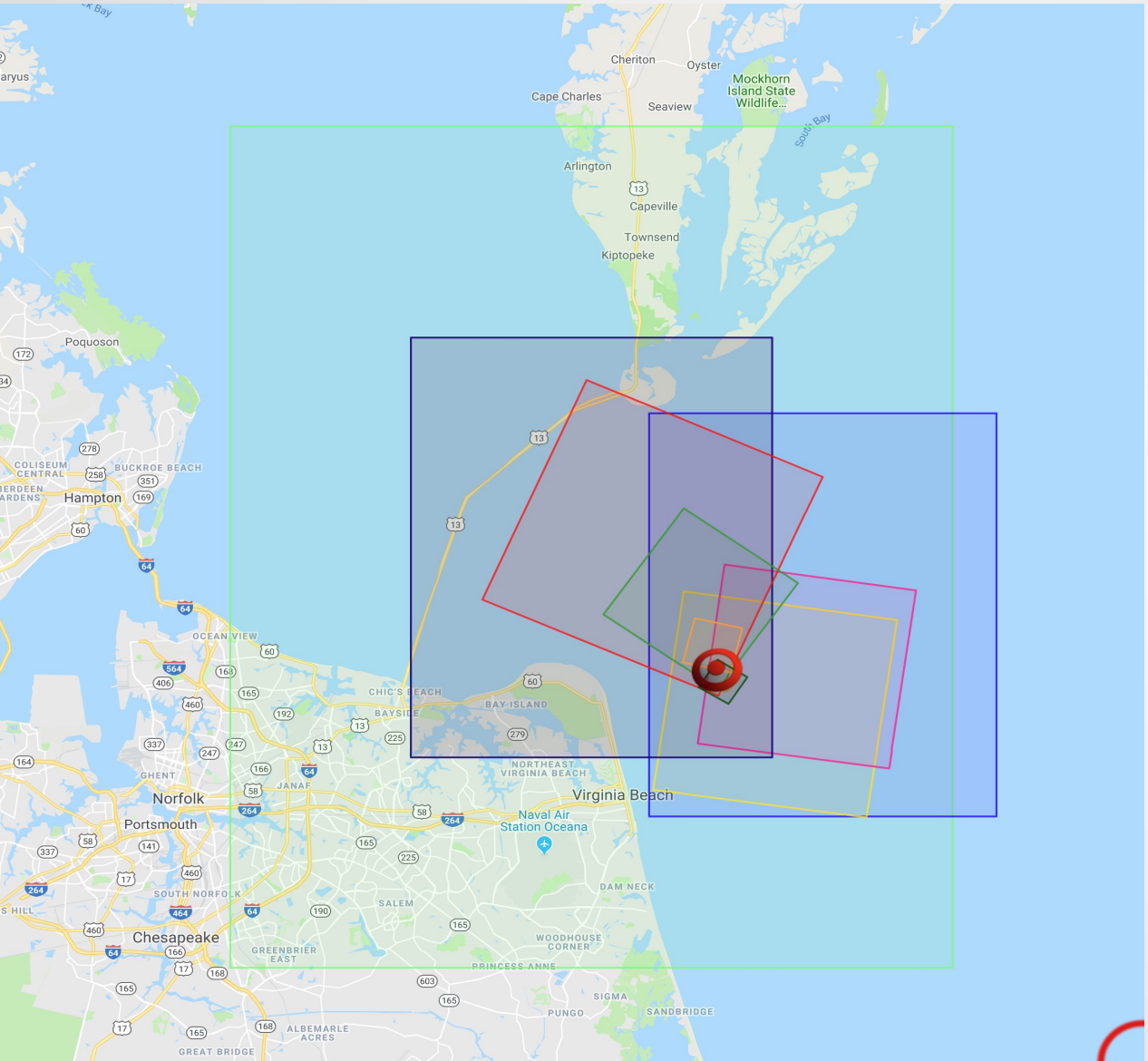
500mb height Day-5 EURO fcst 90%+ correct ¾ of the time.



Short term skill varies (EURO (ECM) skill drop Sep21-Sep26), but over a month EURO is always #1 / UKMet #2 / GFS #3.
NOTE: GFS has been replaced by FV3, which consistently has (slightly) lower skill.
LINK:http://www.emc.ncep.noaa.gov/gmb/STATS_vsdb/



Grid boxes, various models. Models assume uniform conditions within each gridbox. Models are therefore unable to resolve any feature (weather or topographical) which varies within a gridbox. If you want a marine forecast, the gridbox should not be partly over land.



Numerical Weather Models

Agency	Model	Info
	HRDPS Continental (GEM-LAM)	2 Day Forecast, 2.5 km res.
	RDPS (GEM-REG)	2 Day Forecast, 10 km res.
	GDPS (GEM-GLB)	10 Day Forecast, 25 km res.
	GEPS	16 Day Forecast, 0.5 degree res.
	HRRR	18 hr Forecast, 3 km res.
	RAP	21 hr Forecast, 13 km res.
	NAM	3.5 Day Forecast, 12 km res.
	SREF	87 hr Forecast, 16 km res.
	GFS	10 Day Forecast, 0.25 degree res.
	GDWPS Global	5 Day Forecast, 0.25 degree res.
	GFS UV Index	5 Day Forecast, 0.5 degree res.
	Ocean Modelling Branch - Fog	7 Day Forecast, 1 degree res

Forecast Model Error

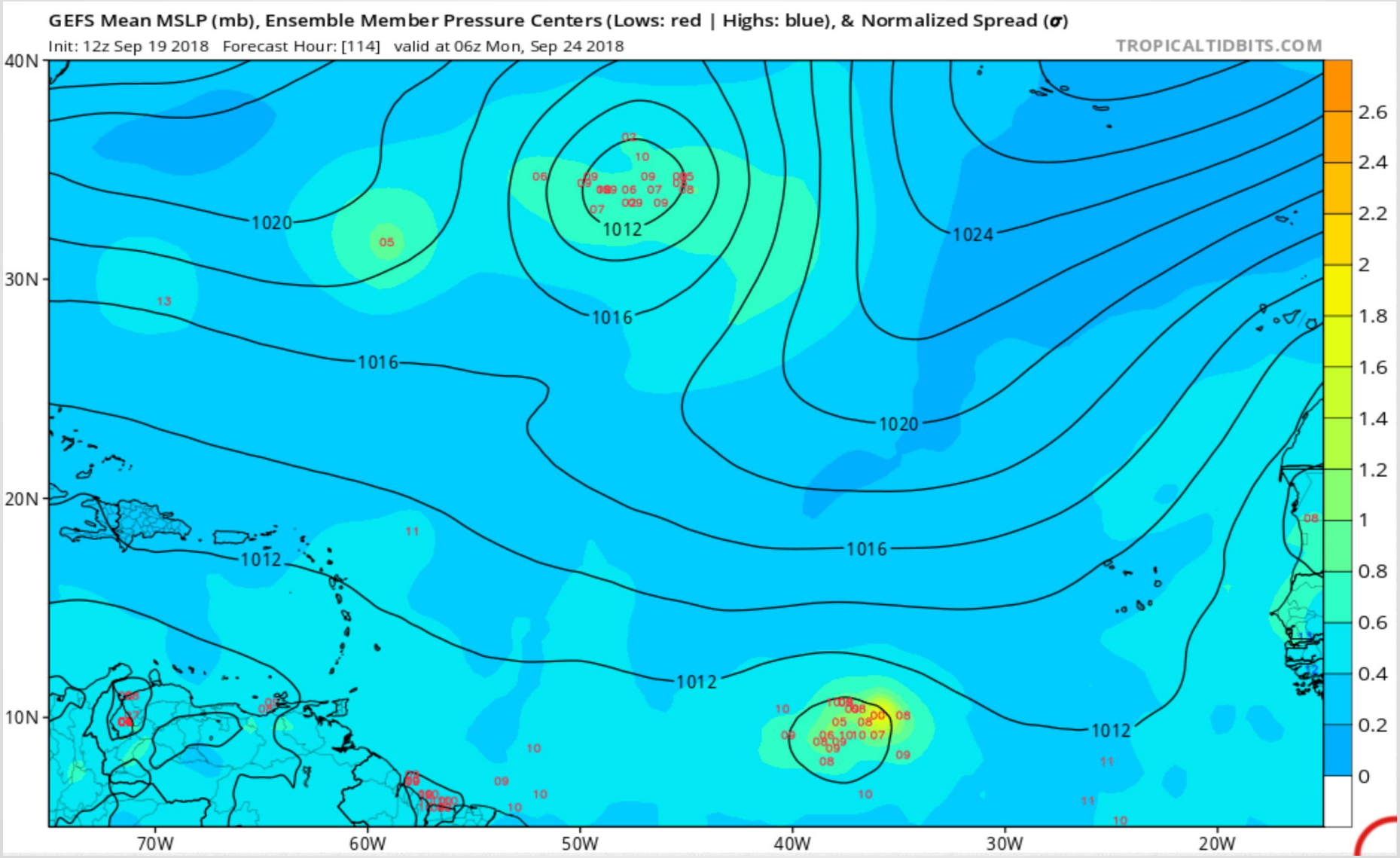
- Start by building the initial state of the atmosphere, via observations from buoys, satellites, ships, planes, balloons.
- Errors approximating initial state of the atmosphere
  - Observations must be properly defined data in models terms (kts vs mph)
  - Uncertainty/ambiguity in observations (instantaneous vs averaged)
  - 3D (or false-4D) vs true 4D observation assimilation
  - interpolated / assumed observations where there's no observation
- Resolution: predictions for "grid boxes" (from 1km x 1km to 100km x 100km in size, with GFS 13km x 13km / EURO 9km x 9km), and assume uniform topography, weather, etc., within each gridbox. Also assume uniform weather between forecast times.
- Any topography or weather event less than about 20-120mi across or 2-24 hrs in duration can not be resolved/predicted. Often includes:
  - Convection and other small-scale weather is disuniform, but model treats as uniform within gridbox
  - Uneven topography assumed uniform within gridbox
  - difficulty resolving interaction with surface (ocean/land)
- Equations are imperfect, and contain small errors
- Small errors compound over time, so longer range forecasts are typically less accurate

Ensemble Forecasts

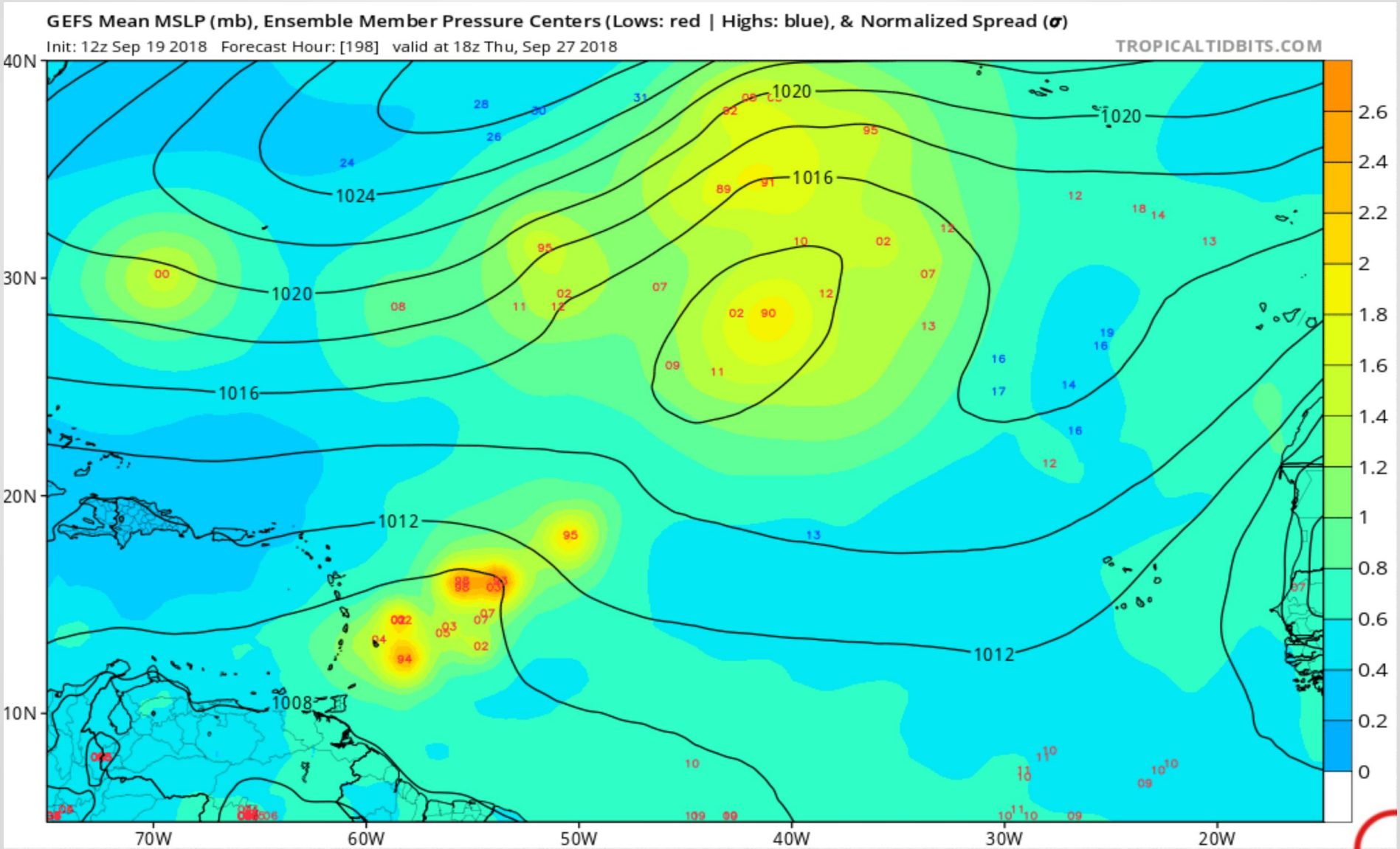
- Ensemble forecasts are vital to long-range forecasting.
- 20-50 different sets of initial conditions, some tweaking of computations for efficiency
- Yields 22-52 different forecast solutions (Operational + Control + 20-50 Ensemble Members)
- Use to see range of possibilities for "high-impact" weather events (strong LO or HI pressure systems) in the long range (6-15 days)
- Access before leaving Port, via
- (GFS): TropicalTidbits.com
- or (EURO):

https://lab.weathermodels.com/models/ecmwf/eps_global_cyclones.php

GFS Ensemble forecast, at 114 hours, showing good clustering (in location & strength) of LO pressure systems E of Caribbean and SW of Azores...suggesting relatively high confidence forecast.



GFS Ensemble forecast, at 198 hours, showing poor clustering (in location & strength) of LO pressure systems E of Caribbean and SW of Azores. Clustering of solutions is closer (suggesting a higher confidence forecast) for feature E of Caribbean than for feature SW of Azores.



Weather resources for the Race:

PredictWind (efficient offshore access to ECMWF model, as well as GFS, but caution against PWE / PWG)

OCENS WeatherNet / GRIB Explorer (HYCOM gridded currents, GFS weather forecast model, as well as NAM & HRRR)

Expedition & MaxSea have weather data built-in, but not ECMWF.

7 main topics:

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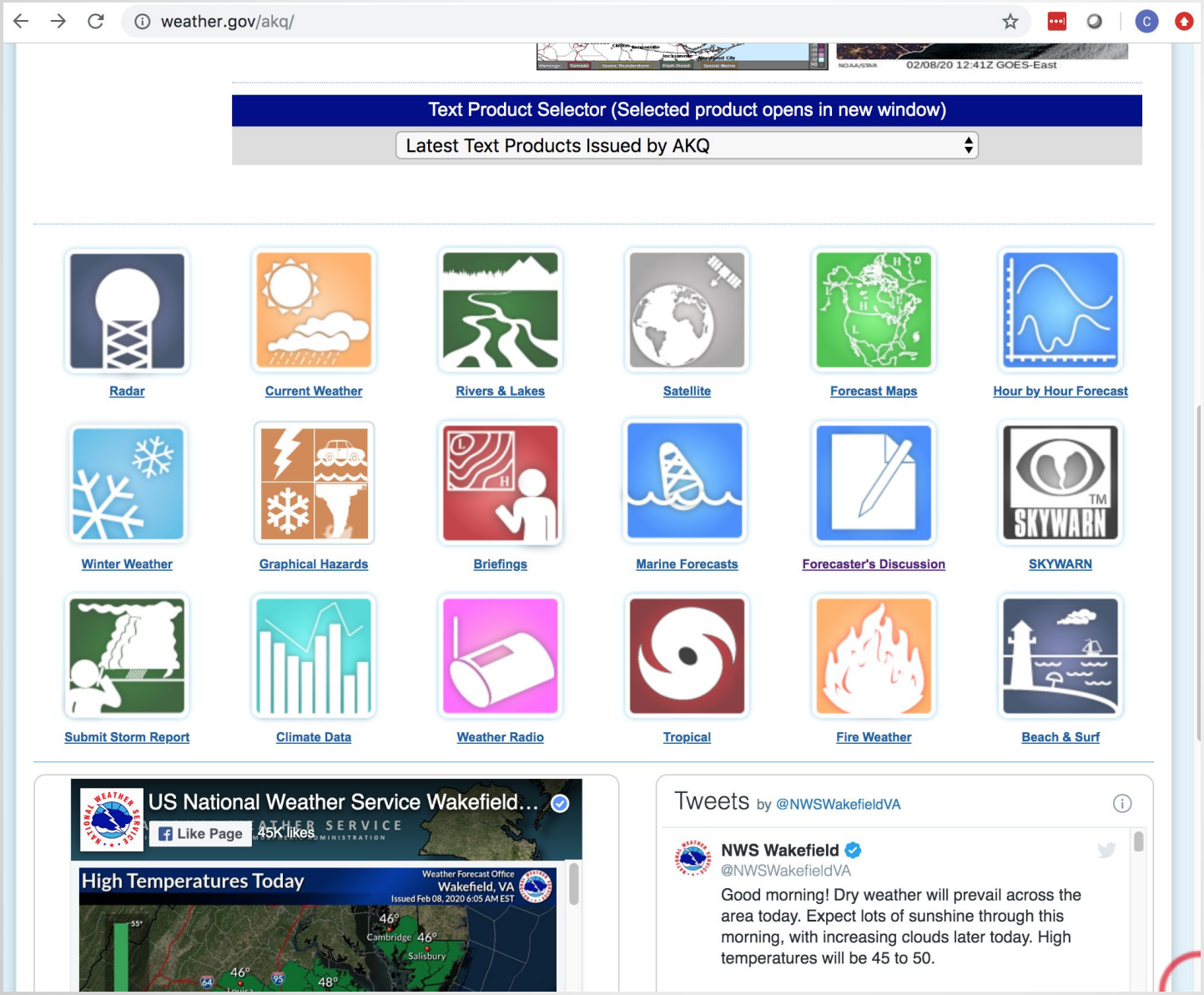
4. NOAA weather resources

Coastal Marine forecasts: www.weather.gov click on area of interest, scroll down to this area, click "Forecaster's Discussion":



Area Forecast Discussion

Issued by NWS Sterling, VA

Current Version | Previous Version | Text Only | Print | Product List | Glossary Off

Versions: **1** 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

-- Highlight Changed Discussion --

000
FXUS61 KLWX 080857
AFDLWX

Area Forecast Discussion
National Weather Service Baltimore MD/Washington DC
357 AM EST Sat Feb 8 2020

.SYNOPSIS...
Weak high pressure will move offshore to our south today. A weak wave of low pressure will pass through tonight. High pressure to the south will control the weather for Sunday. A cold front will stall out near the area Monday. A wave of low pressure will track along the boundary, passing through Tuesday. The boundary may hang around near the area through Thursday with more waves of low pressure bringing unsettled conditions. High pressure will briefly build in from the north late next week.

&&

.NEAR TERM /THROUGH TONIGHT/...
Low pressure continues to rapidly move northeast toward Nova Scotia this morning and high pressure is building to our south. A longwave upper-level trough remains overhead.

For the rest of today, the high to the south will control the weather pattern, but it will slide offshore and an upper-level disturbance in the longwave trough will approach the area from the west. The approaching upper-level disturbance will cause some high and mid-level clouds, but there will be some sunshine as well, and max temperatures will be near climo (40s for most areas with 30s in the mountains).

The upper-level disturbance will pass through the area tonight. This system is strong enough to show some reflection at the low-levels, with most guidance showing a weak wave of low pressure at the surface. This means the low-level flow will be backed some allowing for isentropic lift. However, this system will have very little moisture associated with it. Also, it appears that the best forcing from the upper-level jet and shortwave energy will be to the south while the better isentropic lift will be to the north. Therefore, it is more likely that many locations will end up dry, and if there is any precipitation it will be light. The best chance for precipitation will be near the Allegheny and Potomac Highlands

&&

.LONG TERM /MONDAY THROUGH FRIDAY/...
Subtropical ridging will persist over the Southeast while a polar low spirals near Hudson Bay. This pattern puts the Mid-Atlantic in the gradient between colder air to the north and warmer air to the south. A surface front will likely be near the area for much of next week, but models are expressing high variability in finer scale details.

For now, it appears a disturbance along the front may bring precipitation to the area Tuesday, with a relative dry period Tuesday night into Wednesday. Another wave likely approaches Thursday before most model guidance suggests the frontal system drops southeast away from the area by next weekend, although stubborn ridging to the south could counter this trend.

&&

.AVIATION /08Z SATURDAY THROUGH WEDNESDAY/...
VFR conditions are expected most of the time through Sunday night. A wave of low pressure could bring a snow shower to the terminals tonight, especially near KMRB. However, confidence is low due to low-level dry air.

Sub-VFR possible in rain Monday into Tuesday, likely improving to VFR Wednesday.

&&

.MARINE...
A Small Craft Advisory (SCA) is in effect for early this morning for the Maryland portion of the Chesapeake Bay and lower tidal Potomac River, but winds will continue to gradually diminish today with high pressure to the south. A wave of low pressure will pass through tonight and high pressure will build to our south again for Sunday. Winds should be below SCA criteria for most of this time today through Sunday.

Winds will strengthen a bit Sunday night into Monday ahead of an approaching cold front. A SCA may be needed for portions of the waters. Lighter winds are likely Tuesday.

&&

.LWX WATCHES/WARNINGS/ADVISORIES...
DC...None.
MD...None.
VA...None.
WV...None.
MARINE...Small Craft Advisory until 6 AM EST early this morning for
     ANZ530>534-537-539>541-543.

&&

ocean.weather.gov/mobile/mobile_product.php?id=NFDMIMATN

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AGNT40 KWNM 080800
MIMATN

Marine Weather Discussion for N Atlantic Ocean
NWS Ocean Prediction Center Washington DC
300 AM EST SAT 8 FEB 2020

.FORECAST DISCUSSION...Major features/winds/seas/significant
.weather for the North Atlantic Ocean W of 50W from 30N to 50N.

The 00z Metop-A Ascat overpass confirmed 60 kt winds over the
eastern Gulf of Maine, and to 53 kt over the northern portion of
the outer Georges Bank ANZ900 zone. Subsequent Metop-A and -B
passes also showed gale force winds across the remaining
offshore zones extending south to Cape Fear. The generally
higher 00z GFS first sigma level winds appeared to be the best
initialized with these winds. Buoy observations over the coastal
and offshore areas are indicating that the gale force winds are
slowly diminishing from southwest to northeast, with winds
likely already below gale force over all the inner Mid-Atlantic
zones. Any lingering storm force winds over Georges Bank or the
Gulf of Maine have also shifted east of the offshore waters. The
gale hazards associated with the intense surface low now over
the Gulf of Saint Lawrence should shift east of the remaining
offshore zones later this morning, at which time another cold
front is expected to exit the New England coast. The 00z
GFS/ECMWF/UKMET are consistent in showing gale force winds again
developing with this front at least over the Gulf of Maine and
potentially into the northern portions of Georges Bank around
midday today through this evening. Through tonight, we updated
the wind grids with a 50/50 blend of the previous grids and the
00z GFS first sigma level winds. Gale hazards into this evening
will remain unchanged from the previous forecast, with
confidence in these hazards above average.

High pressure centers are forecast to move east over the New
England and southern NT2 waters late tonight and Sun with
diminishing winds and seas. Models are then generally consistent
with another cold front approaching the New England and northern
Mid-Atlantic coasts Mon and moving offshore Mon night, and winds
increasing to 25 or 30 kt for the waters north of Cape Fear.
Once the front stalls near 38N or 39N Tue, models forecast a
frontal wave to develop and pass east and northeast along the
front later Tue and Tue night. The 00z GFS and 00z ECMWF
remained consistent with the timing of this low as well as with
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Marine Interpretation Message for Atlantic (search MIMATN)
Fetch this offshore via SailDocs (www.saildocs.com)
Or OCENS WeatherNet (www.ocens.com)

front later Tue and Tue night. The 00z GFS and 00z ECMWF remained consistent with the timing of this low as well as with the marginal gale force winds forecast to develop over the outer northern NT2 waters north of Hatteras Canyon mainly near the Gulf Stream Tue into Tue night. Once this surface low passes east of Georges Bank Tue night, the 00z ECMWF/UKMET/CMC all are stronger than the 00z GFS with the northwest winds over the NT1 and northern/central NT2 waters in the wake of the cold front. Based on the latter, we will introduce gale hazards early Wed, but only over the northern offshore zones generally east of 69W. Confidence is again above average with both of these gale events. The northwest gales are expected to quickly shift east of the offshore waters by Wed afternoon as high pressure moves off the Mid-Atlantic coast Wed evening. The wind grids for the period from Sun through Wed night are based on a blend of the 00z ECMWF and the previous forecast grids.

.Seas: The 00z Wavewatch appears reasonably well initialized with the offshore and west Atlantic wave heights this morning. As the seas are subsiding over the inner waters, the 00z ECMWF WAM seems too slow in lowering the wave heights at the moment. Some of the highest observed wave heights over the last several hours were Georges Bank buoy 44011 at 29 ft at 06z, and as was noted previously a 23z/07 Altika altimeter overpass returned significant wave heights as high as 30 to 33 ft near the Gulf Stream over the outer ANZ925 waters. The highest wave heights have since shifted just east of the offshore waters, although there currently could still be seas close to 30 ft across the far eastern portions of the northern NT2 waters. Through the next 72 hours, the wave height grids were populated with a 50/50 blend of the 00z WAM and 00z WW3. Thereafter given our preference for the ECMWF, the wave height grids were based on the 00z WAM.

Extratropical Storm Surge Guidance: With the strong offshore flow continuing through most of the day, the 00Z ESTOFS and ETSS are consistent with negative surge generally in the -1 to -2.5 ft range along the Mid-Atlantic and New England coasts today. Significant positive surge is not expected along the Mid-Atlantic or New England coasts for the next several days. For more detailed information, refer to products from your local coastal National Weather Service forecast office.

.WARNINGS...Preliminary.
.NT1 New England Waters...

.WARNINGS...Preliminary.
.NT1 New England Waters...
.ANZ800...Gulf of Maine...
Gale today into tonight.
Gale Possible Wednesday.
.ANZ805...Georges Bank west of 68W...
Gale today into tonight.
Gale Possible Wednesday.
.ANZ900...Georges Bank east of 68W...
Gale today into tonight.
Gale Possible Wednesday.

.NT2 Mid-Atlantic Waters...
.ANZ915...Hudson Canyon to the Great South Channel...
Gale today.
.ANZ920...Baltimore Canyon to the Great South Channel...
Gale today.
Gale Possible Tuesday into Tuesday night.
.ANZ905...The Great South Channel to the Hague Line...
Gale today.
Gale Possible Tuesday night into Wednesday.
.ANZ910...East of the Great South Channel and south of 39N...
Gale today.
Gale Possible Tuesday night into Wednesday.
.ANZ925...Outer Waters from Baltimore Canyon to Hatteras
Canyon...
Gale Possible Tuesday into Tuesday night.

$$

.Forecaster Clark. Ocean Prediction Center.

7 main topics:

1. GulfStream
2. Drivers of wind
3. Weather forecast model skill, a bit about models, ensemble forecasts
4. NOAA weather resources
5. Forecasting & routing in terms of "Inflection Points" and "Decision Points"

Departure Timing, Routing, Inflection Point(s), Decision Point(s)

You have limited time / attention.

Focus time / attention on parts of trip which may be problematic - typically when:

- weather changes (wind direction and/or speed change, change in precipitation, etc.) - these are "**inflection points**" in the weather
- decision needs to be made (when to tack, should I shorten sail, should I head into Port?) - these are "**decision points**" along your journey

After you identify **inflection points** and **decision points**, study weather and strategies, then determine optimum departure day/time, routing, strategy and destination to align with your analysis of inflection points and decision points.

Common Inflection Points on A2B race

- ColdFRONTs or other adverse weather early in trip?
- Weather in GulfStream?
- Is there RIDGEing (HI pressure)? (settled weather, typically supporting moderate SSW-WSW winds)
- or TROFiness (LO pressure, TROFs)? (unsettled, changeable weather with squalls and variety of wind directions / speeds)
- Any remnant FrontalTROFs with squalls, risk for Tropical LO formation?

Inflection Point(s)

- For an extended interval of time it's sunny and 70F with wind E@15.
- Now wind is predicted to go away, or veer S, or increase. You need to understand WHY! Probe forecast for "what could go wrong". Examine:
  - Synoptic features (HI/RIDGE (**stable, settled, high confidence in details**) or LO/FRONT/TROF (**UNstable, UNsettled, LOW confidence in details**))?
  - Upper-air influence?
  - Precipitation?
  - Convection, or anything else other than "gradient wind"?
- Focus most of your probing of "what could go wrong" at the timing when you think there's highest chance something goes wrong.

Departure timing, methodology

- Start with departure as soon as weather conditions are predicted to become satisfactory at the departure point.
- Identify "inflection points" in weather / GulfStream, and study them to ensure you understand the nature, drivers, uncertainty and possible evolutions, and their impacts on your vessel.
- How is your timing of arrival at "inflection points"?
- Are you comfortable with expected conditions at "inflection points"?
- Is there a better time/place to encounter "inflection points"?
- Do Ensemble forecasts suggest uncertainty (strength / location / timing) of any high-impact weather events? Are you OK with the range of possibilities?

Departure Timing/Routing and Inflection Points

8 day trip FtLauderdale to Bermuda on Tall Ship ***Oliver Hazard Perry***, April 2017.

Inflection Point #1: ColdFRONT on Day4

Inflection Point #2: possible LO with Tropical characteristics on Days8-10

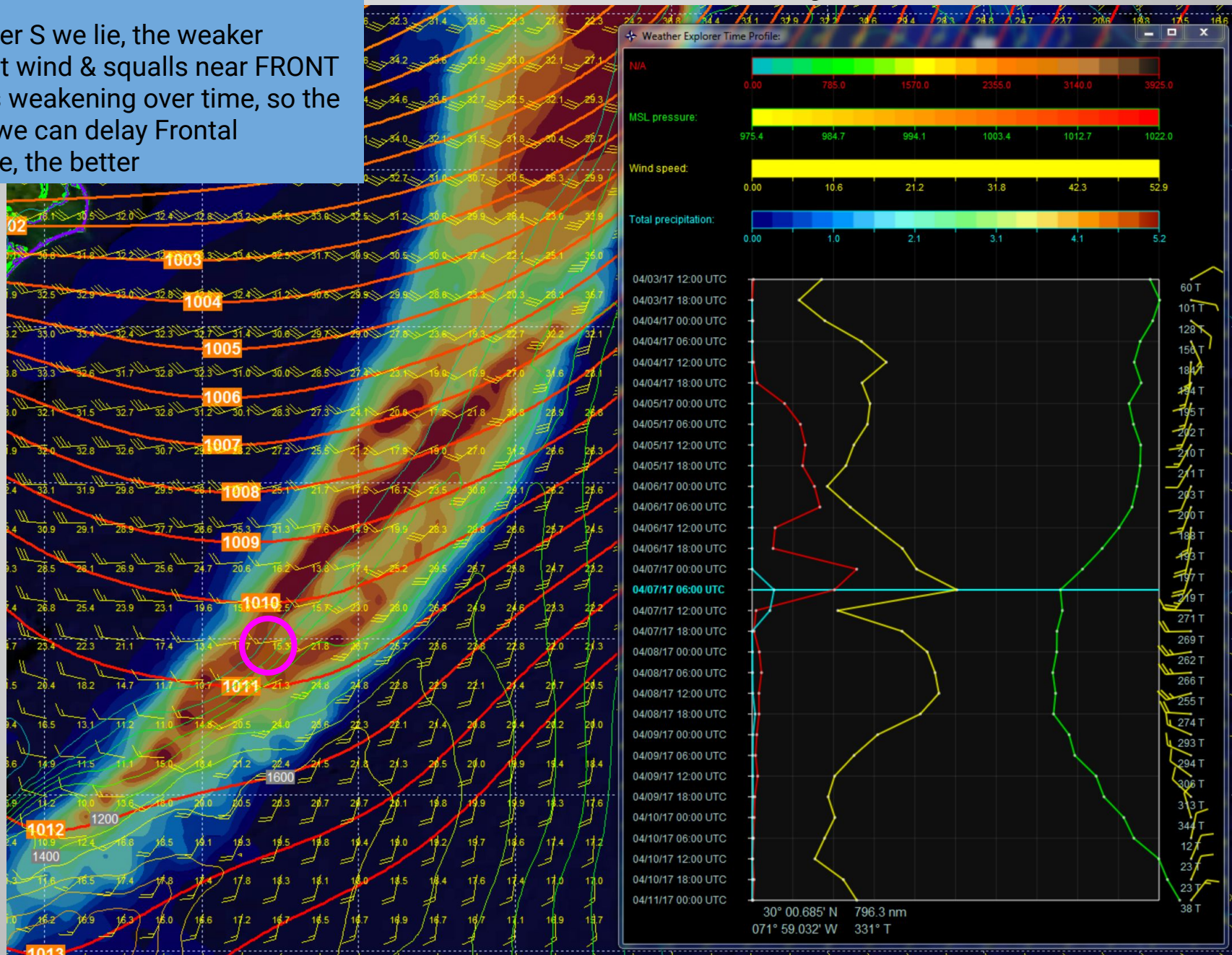
Example of identifying "inflection point" - important interval along trip where conditions change, and use to assess suitability of departure timing and routing:

Inflection Point Day4= Fri7, 0600z

The farther N we lie, the earlier FRONT passes us / farther S FRONT passes later

The farther S we lie, the weaker gradient wind & squalls near FRONT

FRONT is weakening over time, so the longer we can delay Frontal passage, the better



Inflection Point #1, Conclusions

1. **Departure timing is OK, as long as we lie sufficiently far S so ColdFRONT reaches us later, when it's weaker.**
2. **Do NOT get N (left) of the rhumb line to Bermuda, or wind & squalls/T-strms will be MUCH worse / if we want milder weather, favor course S (right) of rhumb line.**
3. **Ensure vessel/crew are well prepared for Thu6 night.**

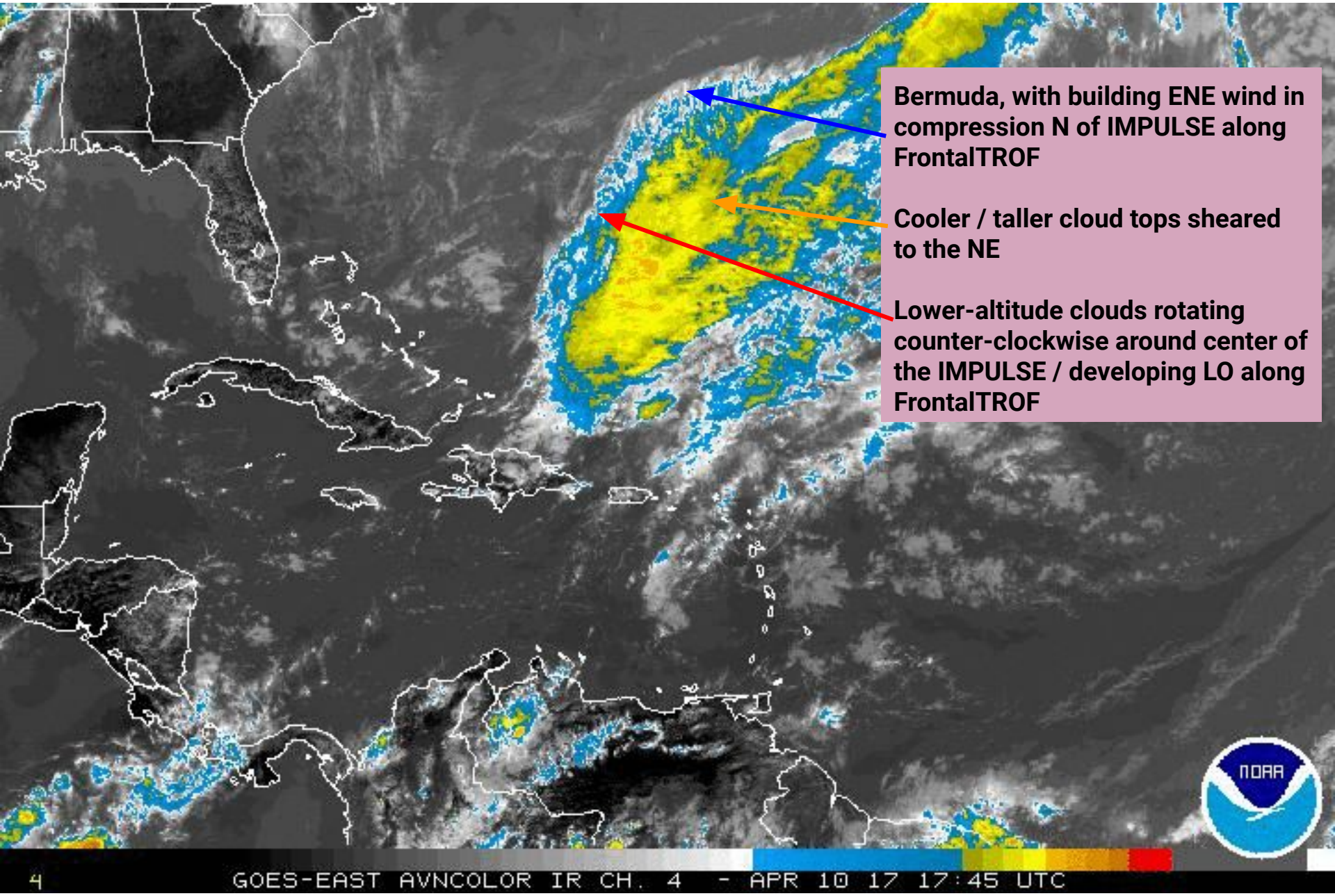
Another Inflection Point

ColdFRONT which passed Day4 stalls S&E of us on Day5, then lingers / festers, and over time a Focal Point/IMPULSE (of energy) forms along quasi-stalled FrontalTROF. Probe forecast for plausible evolutions of this IMPULSE of energy

Conclusion = plausible LO with Tropical characteristics on Day8-Day10, and plausibly lifting N toward Bermuda

Influence on forecast for us = chance of gradually building ENE headwinds Day8-Day10.

Day8 (Mon10) Enhanced Infrared Satellite loop



Inflection Point #2, Conclusions

Do not delay departure.

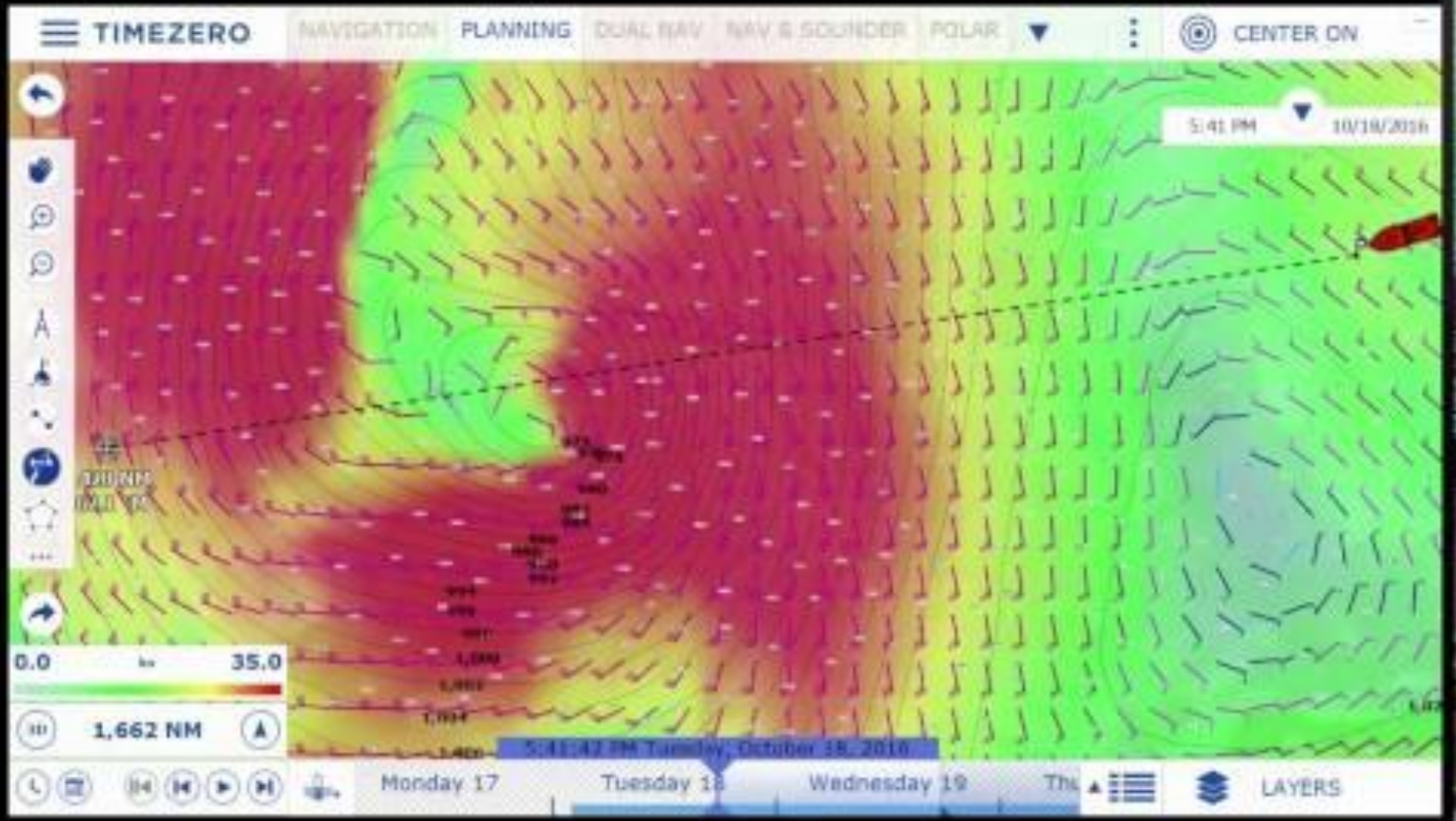
During intervals of light wind motor/motorsail to maintain speed so we arrive on Day8.

7 main topics:

1. GulfStream
2. Drivers of wind
3. Weather forecast model skill, a bit about models, ensemble forecasts
4. NOAA weather resources
5. Forecasting & routing in terms of "Inflection Points" and "Decision Points"
6. **Weather routing software**

Route Optimization

- Optimum routing depends on the GOAL. In a race, it's all about speed.
- When Cruising, it's all about safety and comfort...but generally comfort is maximized by broad reaching in moderate conditions - which also tends to maximize speed!
- Computer models optimize routing, but depend on weather forecast model being correct, and you sailing boat to its performance polars (neither of which is usually realistic).
- Computer models calculate "isochrones" (lines of same time) - you could sail your boat to anywhere along the LINE by a given time (6 hours from now).
- Given a starting point at every point on this LINE, where can you sail to in the following 6 hours? This is your next LINE.
- Given a starting point at every point along that LINE, where can you sail in the following 6 hours? This is your next LINE, and on and on. First isochron to reach destination shows fastest route.


TIMEZERO
NAVIGATION
PLANNING
DUAL NAV
NAV & SOUNDER
POLAR
CENTER ON
5:41 PM
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kn
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1,662 NM
Monday 17
Tuesday 18
Wednesday 19
LAYERS

Optimum Routing

- Start with earliest possible departure and a Great Circle Rhumb Line Route
- Understand large scale weather pattern / synoptic features then "probe" forecast for uncertainties (including convection/support for lifting and unsettled weather...as well as boundary layer effects). Ask "what could go wrong with the weather?"
- Keep away from conditions which may exceed safety threshold - especially if wind driven by other than "gradient wind"
- Maximize comfort - on a sailboat this is generally broad reaching in moderate wind/sea conditions.

(HINT: consider telescoping jib pole to make downwind sailing more fast, comfortable, and a "Code-0" sail to make light air sailing more fast, comfortable)

- Maximize speed - as long as you are not sacrificing safety or comfort, increasing speed usually enhances both safety and comfort (the longer you are at sea, the greater the risk something goes wrong...and boats are more comfortable when they're moving efficiently and well-sailed).
- Waypoints? Not always - Instead of sailing to waypoint, try sailing constant apparent wind angle, or sailing consistent angle-of-heel.

7 main topics:

1. GulfStream
2. Drivers of wind
3. Weather forecast model skill, a bit about models, ensemble forecasts
4. NOAA weather resources
5. Forecasting & routing in terms of "Inflection Points" and "Decision Points"
6. Weather routing software
7. **Weather patterns likely during A2B Race**

5 main topics:

1. **GulfStream**
2. Weather forecast model skill, a bit about models, ensemble forecasts
3. Select optimum departure timing (for safety, comfort, speed)
4. Optimize routing (for safety, comfort, speed)
5. Common mistakes

5 main topics:

1. GulfStream
2. **Weather forecast model skill, a bit about models, ensemble forecasts**
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4. **Optimize routing (for safety, comfort, speed)**
5. Common mistakes

5 main topics:

1. GulfStream
2. Weather forecast model skill, a bit about models, ensemble forecasts
3. Select optimum departure timing (for safety, comfort, speed)
4. Optimize routing (for safety, comfort, speed)
5. **Common mistakes**

Marine Weather Center Forecast Emphasis - 4 parameters:

- Wind speed & direction (knots in degrees True, so you're aware of TRENDS – 040@14 today / 050@12 tomorrow)

"<" sign to describe TREND in conditions

- Precipitation (use to validate wind forecast – estimate of wind during precipitation, also consider instability)
- Seas (height, period & direction – seas are driven by wind)
- Sea Surface Currents

END

Top 7 Weather Mistakes

1. On a schedule
2. Crew accompanying you
3. Depart too late
4. Depart in deteriorating conditions
5. Make decisions too-early
6. Inflexible (won't alter destination, schedule, other details)
7. Mismatched expectations

Top 7 Mistakes – On a schedule

- Only schedule should be whatever makes for an acceptable level of safety, comfort
- Inconvenience and some expense is better than damage to boat, crew
- Lesson from SDR, 2013

Top 7 Mistakes – Crew accompanying you

- Are POBs for extended period of time 24/7/365?
- If so, then you can be in a "nearly perpetual state of preparedness to put to sea".
- If some crew is temporary, then you are certain to feel pressure (from them or you or both) to maintain a schedule, so temporary crew can disembark to resume their normal lives.

Top 7 Mistakes – Depart Too Late

- When weather is bad, don't hang-out in the bar - instead, be making preparations so you can go as soon as weather improves.
- Human nature to assume current bad weather will continue.
- Instead, best departure may be immediately after bad weather subsides.
- Good weather lasts only so-long – don’t waste any getting prepared; use bad weather to get prepared & be prepared to depart as soon as weather improves.

Top 7 Mistakes – Deteriorating Conditions

- Similar to “Departing Too Late”, it’s human nature to assume presently-OK (but deteriorating) conditions will continue.
- More likely is trend toward deterioration continues & becomes NOT-OK soon.
- SDR, 2013

Top 7 Mistakes – Decisions too Early

- Another example of human nature – we like to know what we're going to do.
- 1st decision: is this the optimum time to make the decision? If you delay making decision, will you have better information (delay making decisions until you have better info on which to base decision)? Or will you have fewer options (balance - if you wait too long, you lose options)?
- Better to leave as many options open as possible, so if something unexpected occurs, you have maximum number of options.
- Make decisions as late as possible, so you can incorporate the best information in your decision-making...but not so late you have few options.

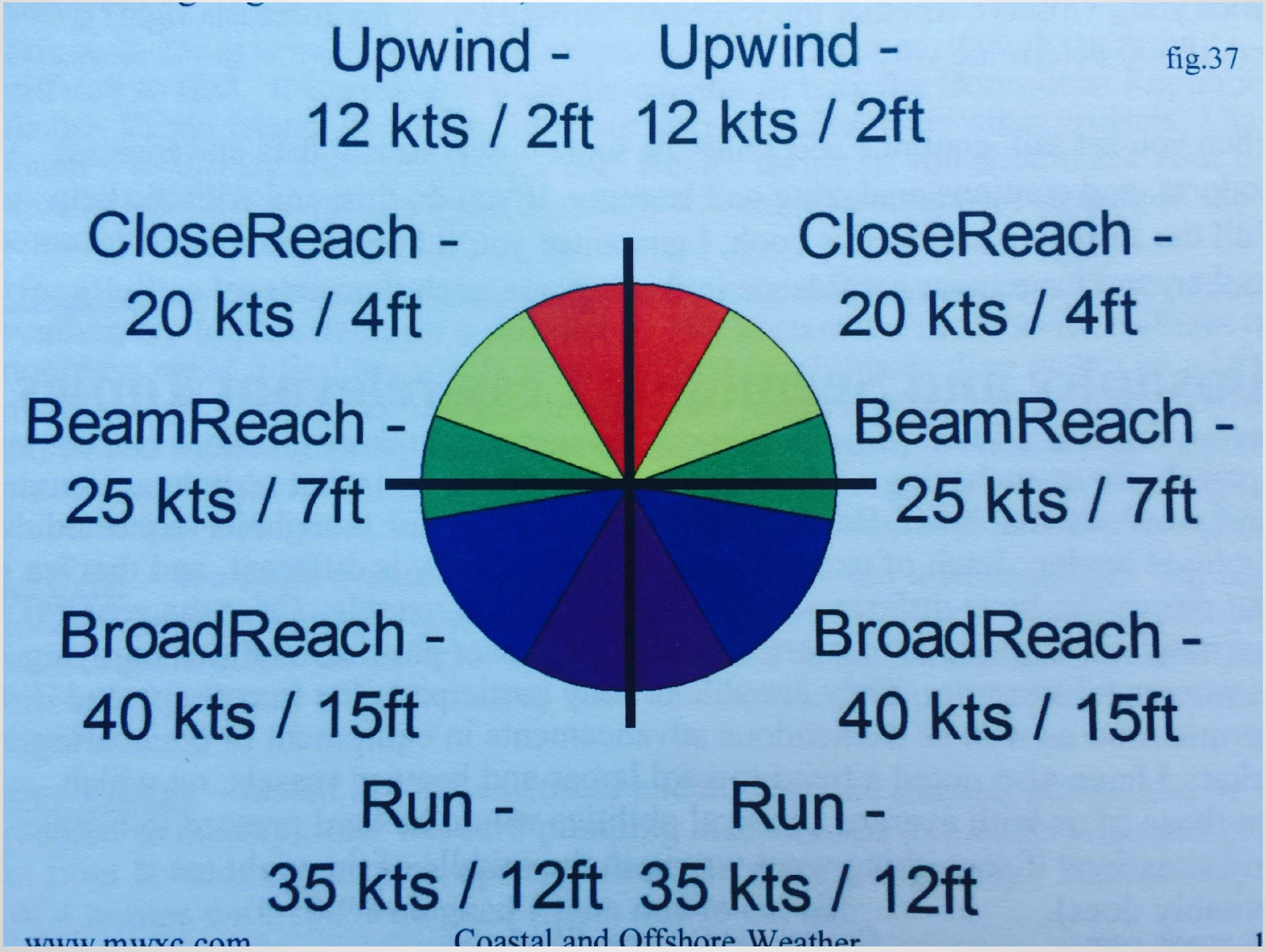
Top 7 Mistakes - Inflexible

- Have you heard: “Plan your work & work your Plan”? Make decisions & stick to them – no matter what.
- Objectivity - Hear what you want to hear (you like when world conforms to your plan).
- Who suffers most: “Type-A” & Successful & Pilots & Men.
- Michael's dad
- Better: remain flexible, keep options open

Top 7 Mistakes - Mismatched Expectations

- What is your GOAL?
  - Delivery
  - Day-trip
  - Fishing
  - Pleasant vacation
  - Long ocean voyage
- Decision Wheel

DECISION WHEEL



Wrap-up...how can we help?

Services

- High-value-added forecasts and routing advice, available by communications method(s) you prefer:
  - SSB Radio Voice, Email, Telephone, SMS message
- Subscriptions by the Year, Month, or just a Single Forecast. As little as $30 for a single forecast (Annual Subscriptions less than $1/day)
- Focus on information you need to make good decisions. Start with Daily Regional Email forecast ($199/yr).
- COMBO SSB Nets & Regional Email $299/yr - help us grow (7 days/week coming when we can)!