

A 'superBT' for TC Operations & Research

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Space and Naval Warfare Systems Command, Arlington VA

NASA Goddard Space Flight Center, Greenbelt MD

National Centers for Environmental Prediction, Camp Springs MD

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Fleet Numerical Meteorology and Oceanography Center, Monterey CA

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The Bill Gray Standard Seminar Question

20140401 AMS Hurr Conf San Diego

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**This is all well and
good Mike...**

The Bill Gray Standard Seminar Question

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**This is all well and
good Mike...**

**but why are you
doing this?**



*This work is unfunded...
the real reason...*



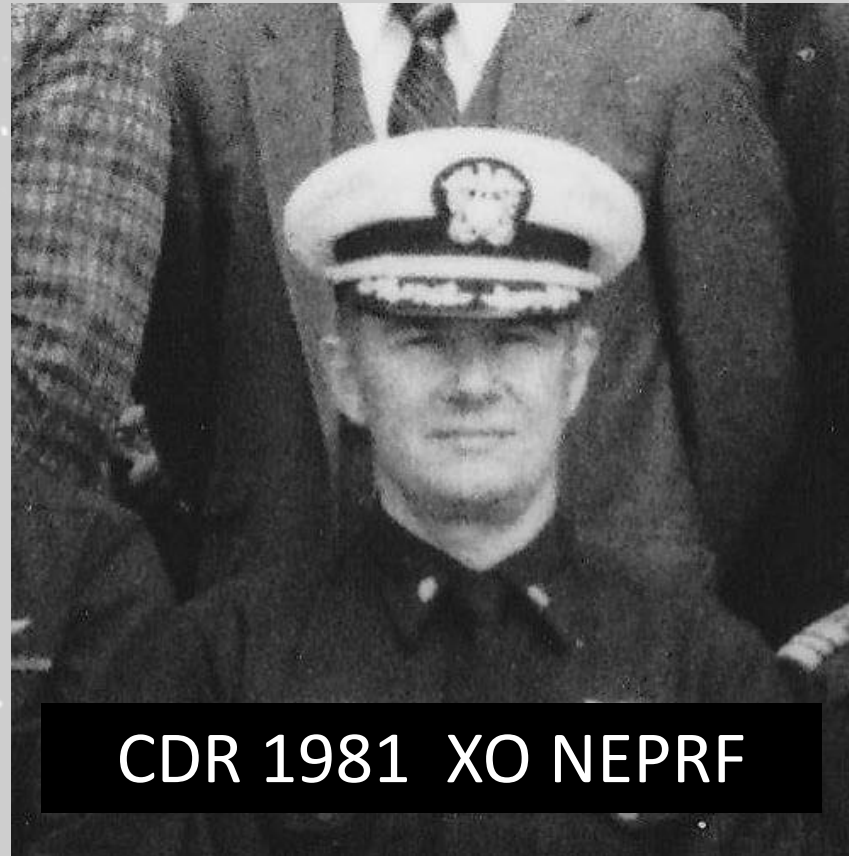
*This work is unfunded...
the real reason...*

Alzheimer's avoidance 🤔

- 1) *geeking -- TCs & NWP & computers*
- 2) *毎日日本語を勉強しています – I study Japanese every day to rewire my brain...*

Acknowledgements

- Jim Kinter, COLA/GMU
 - sponsors my affiliated faculty position (essentially emeritus) at George Mason U since 2021
- Yukari Takayabu-sensei
 - sponsoring my visiting professorship at U of Tokyo (“TouDai”)
- Hans Hersbach, ECMWF
 - ECMWF computer account and access to ERA5 forecasts
- Russ Elsberry (NPS), Rick Anthes & Tom Warner (PSU)
 - everything I every knew about the science of TCs and modeling I learned at PSU & NPS



CDR 1981 XO NEPRF

Special Acknowledgement to my “Sea Daddy” (Mentor)

CAPT Ed Harrison USN (dec)
everything I ever knew about the Navy and
TC forecasting...

- **1st NPS PhD in Meteorology 1973** with Russ Elsberry
- ***one-way influence*** limited-area model lateral boundary conditions, ***no bueno, two-way interaction only stable***
- ***JTOPS (deputy JTDIR; now XO) 1974-76***
- ***Personal – set me on a totally different life path***
 - first .gov full-time job at NEPRF
 - turned over his NTCM → 1st operational implementation of a baroclinic, two-way interactive moving nested-grid TC model in the USA in 1982
 - supported my PhD studies with Russ Elsberry
 - honchoed my 1985 USNR commission as an 1805 thru BUPERS → unbelievable Navy Career – ***especially with JTWC as NWP models Officer & TDO***

2024 TCC

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40th Anniversary of the
Momentous 1984 ATC (and the New Sanno) because of

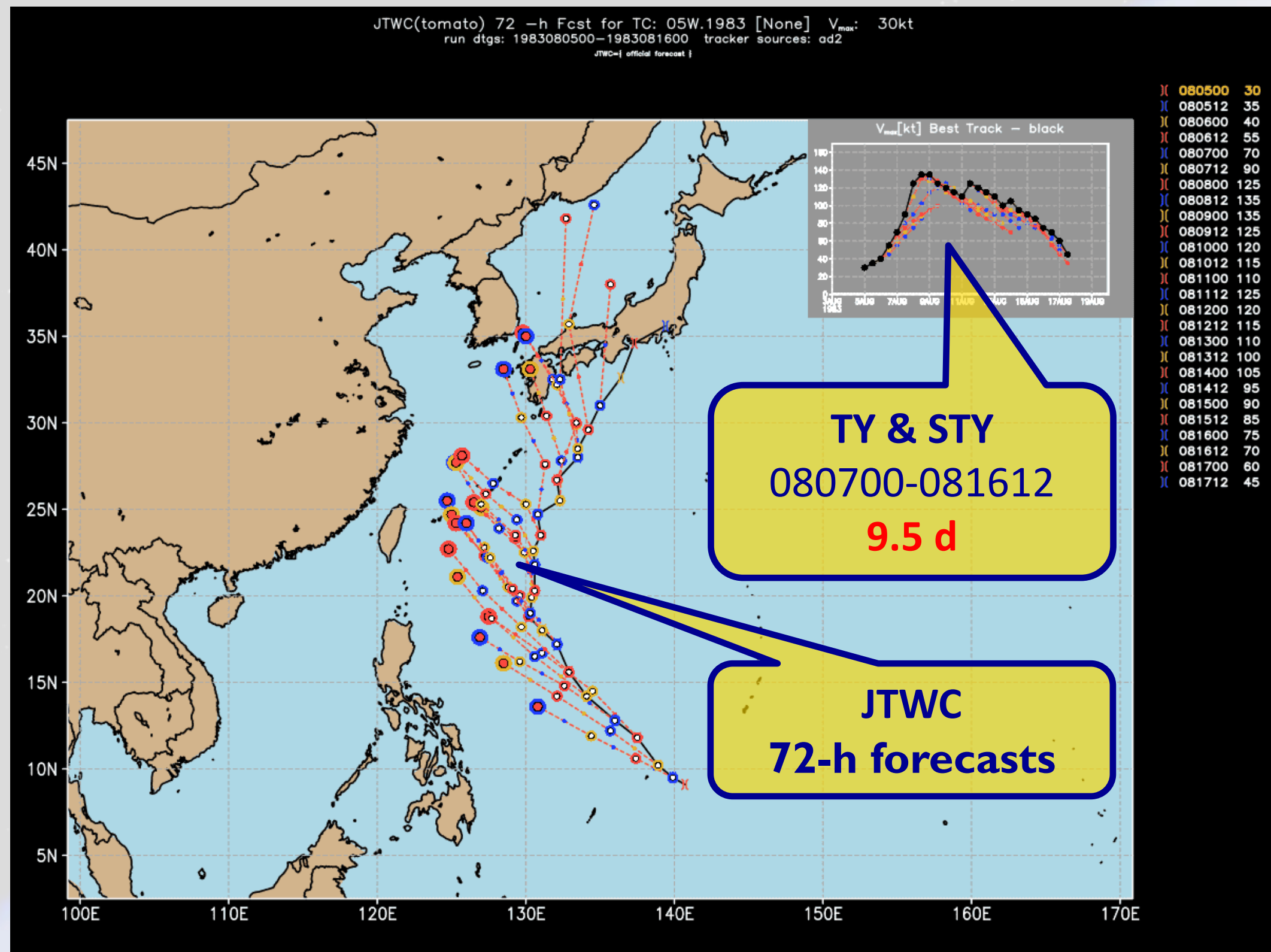
STY ABBY 05W.1983

both personally (no stuff, there I was) and for USN

- COMNAVFORJAPAN was P.O.'d to put it mildly ...
 - ▶ lost half of his summer training cycles because of the *poor JTWC forecasts*
 - ▶ after “attention on deck” made the assembled 06s and the rest of us stand at attention for the chewing out ... a sight to behold ...
 - ▶ *blame always flows downhill* ... as the primary dynamical TC modeler at NEPRF so it was of course *my fault*
- Spectacular ‘failure’ caused a big push (\$\$) to USN TC research
 - ▶ ABBY track error theory was beta gyres forced a ‘break in the ridge’ because of ABBY’s size
 - ▶ **TCM90** – field program to search for the beta gyres...
 - ▶ my PhD research with Russ Elsberry on ‘beta gyres’ 1987

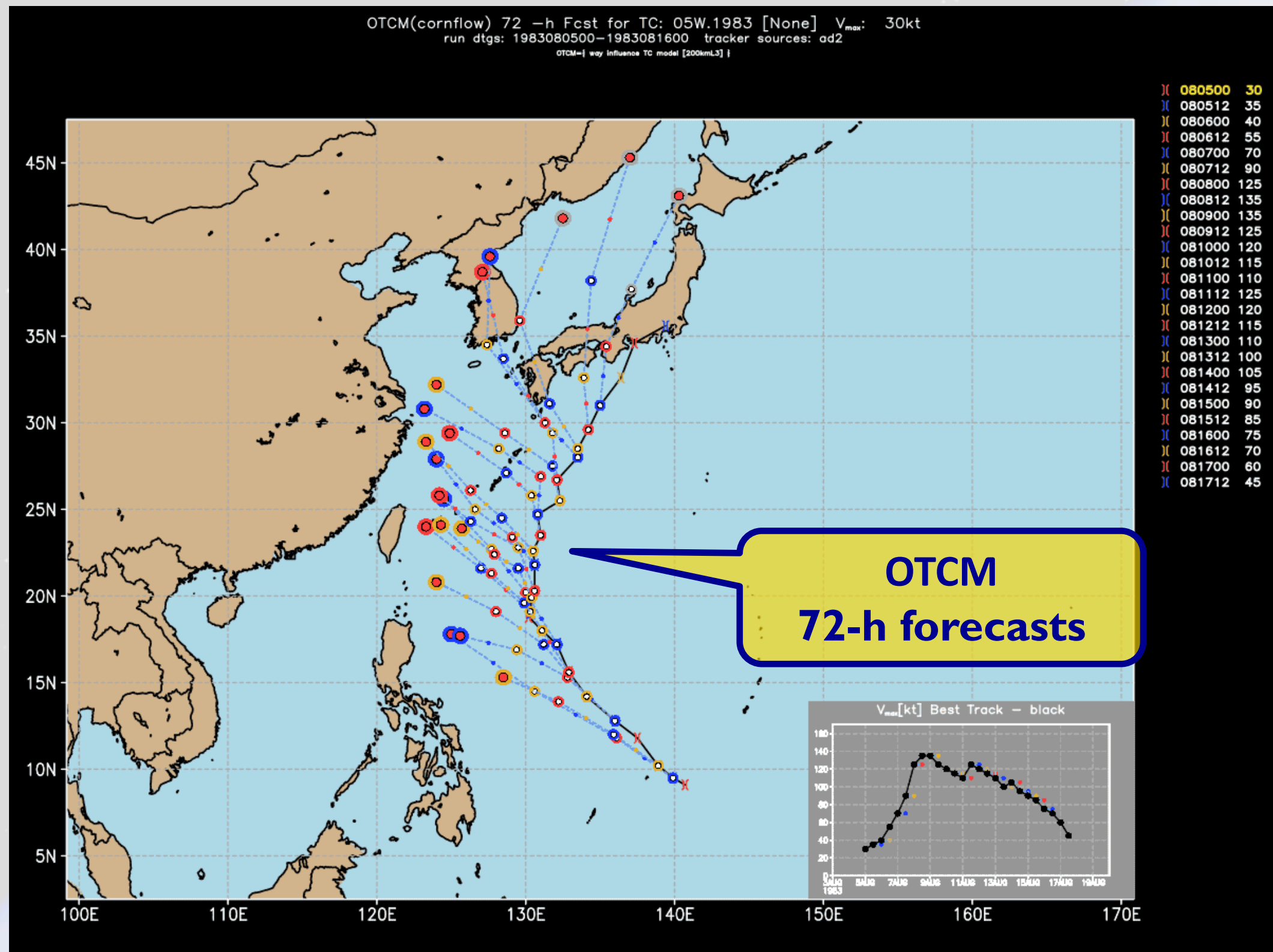
40th Anniversary of the 1984 TCC...STY Abby 05W.1983

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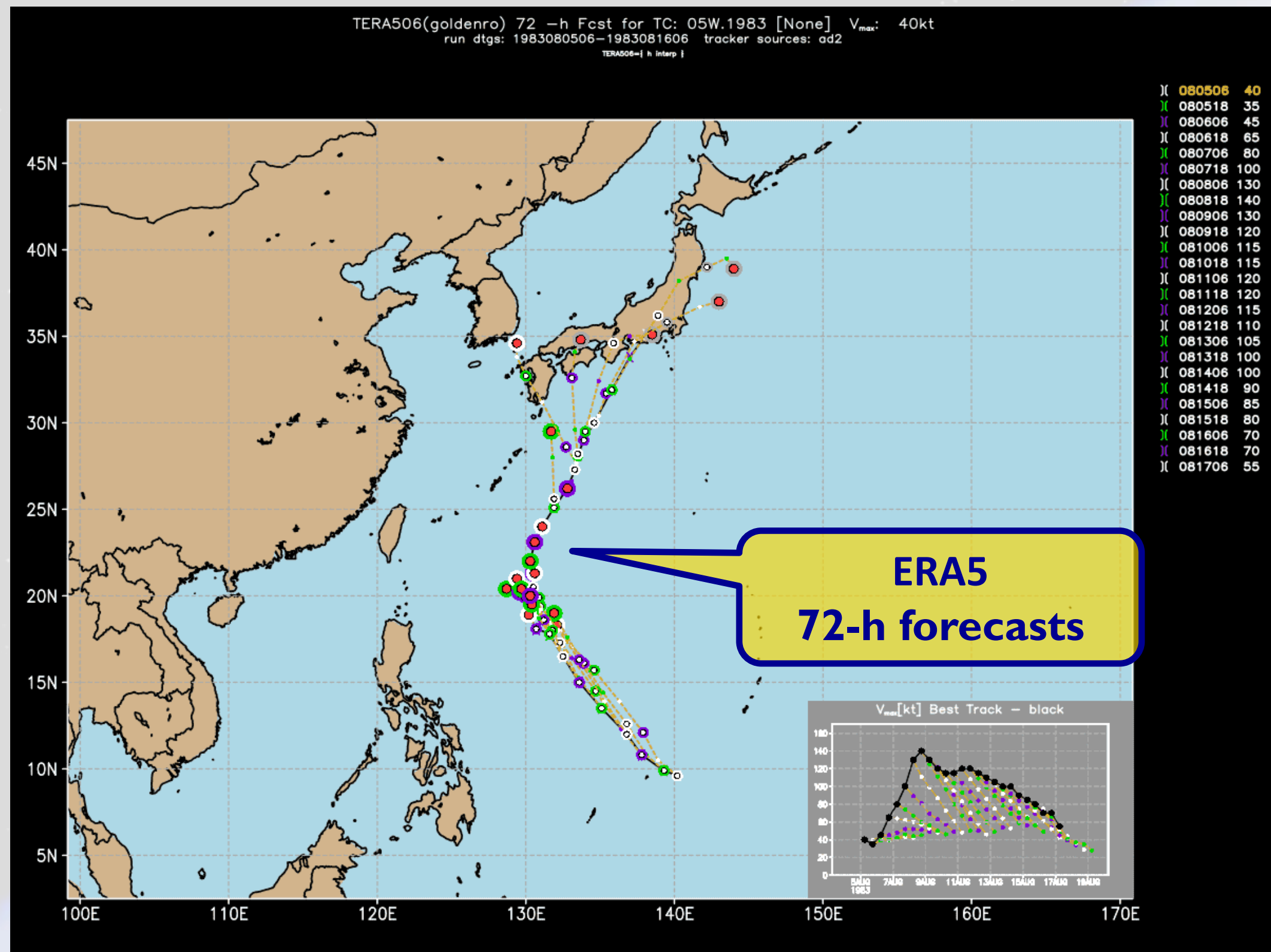


40th Anniversary of the 1984 TCC...STY Abby 05W.1983

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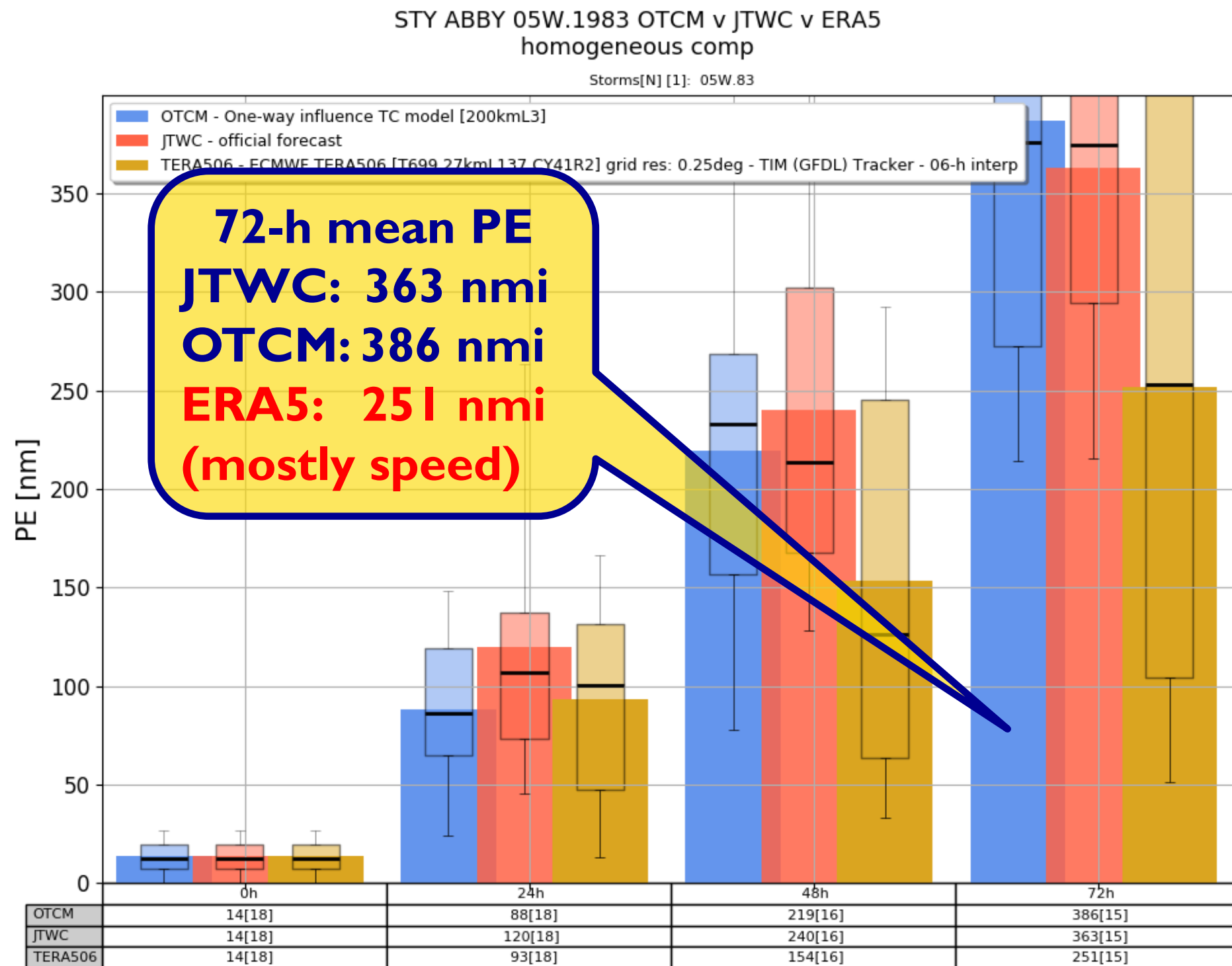


40th Anniversary of the 1984 TCC...STY Abby 05W.1983



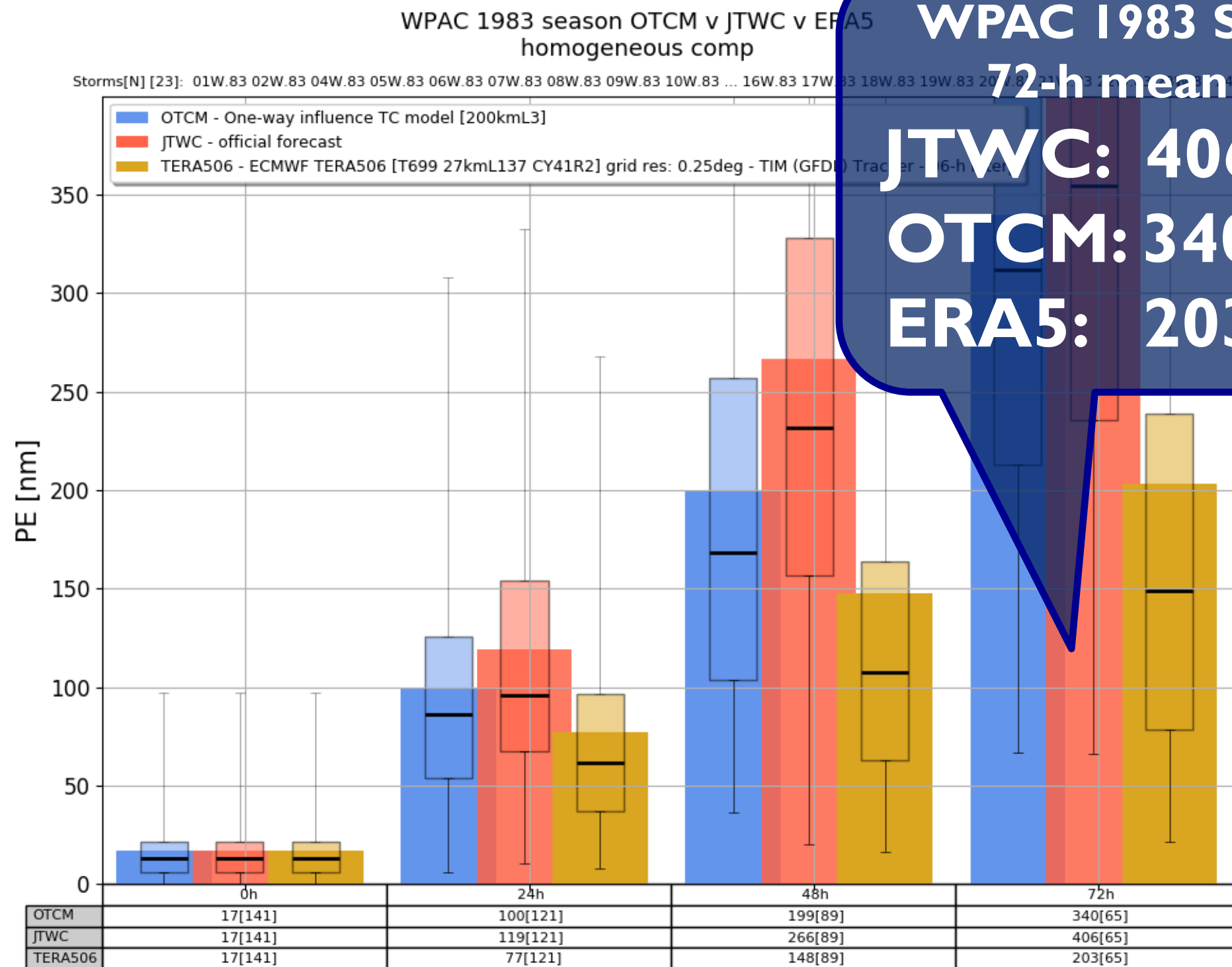
40th Anniversary of the 1984 TCC...STY Abby 05W.1983

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40th Anniversary of the 1984 TCC...STY Abby 05W.1983

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2024 TCC

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40th Anniversary of the

Momentous 1984 ATC because of

STY ABBY 05W.1983

both personally (no stuff, there I was) and for USN

- JTWC had a rough season, but the **ABBY forecasts were typical of the era** ... 72-h mean PE ~ CLIPER ~ 380 nmi
- The forecasts were not 'bad' in terms of mean PE ... just huge impact on operations ... gotta make better forecasts!
- **ERA5 forecasts were much better** ... using the same observing system of 1983 ... because of the modeling (IMHO) ... **good source of dynamical information** for an extended or **super Best Track**...



2016 ...
pTCs & diagnostics file



Validation of Operational pre-potential Tropical Cyclones (pTCs) Using the TC Diagnostic File

Michael Natoli

University of Maryland, College Park

Michael Fiorino

Earth System Research Laboratory, Boulder, CO

What's a 'superBT'?


a partial theft from Krish's 'super ensemble'

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- **superposition** on to a **TC best track** data set of ancillary data from ERA5 (NWP – **dynamics**) and precipitation (**thermodynamics**)
- three data set types:
 - ▶ 'mdeck' – merge data from both adeck and bdeck for both **NN** and **9X**
 - curated 9X 2006-2024 for both **dev** and **non-dev**
 - **formation rate** and **time to formation/dissipation**
 - **genesis defined as first warning vice first TS (≥ 35 kts)**
 - ▶ ECMWF ERA5 reanalysis **00/12 UTC 10-d forecasts**
 - ▶ three hi-res satellite global precipitation analyses
 - CMORPH (NCEP CPC)
 - GsMAP (Japan JAXA)
 - **IMERG (NASA)**
- implementation – github project – V04 (1st beta)
 - ▶ 2007-2022










2024 ...

<https://github.com/tenkiman/superBT-V04>

 **superBT-V04** Public generated from [readthedocs/tutorial-template](#) Unpin Unwatch 1

v04 2 Branches 2 Tags Add file Code

This branch is 2 commits ahead of `main`. Contribute

	tenkiman v04 for TCC@JTWC 20240418-19	129 Commits
 .github/workflows		6 months ago
 dat		2 months ago
 docs		2 days ago
 gadat		yesterday
 plts		yesterday
 py2	v04 for TCC@JTWC 20240418-19	yesterday
 .gitignore	add NB dir under docs to hold NB or errata or problems wit...	4 months ago
 README.md	latest on mike5	2 months ago
 index.html	In -s index.html	3 months ago

python(2) interface

- list TC positions
- StormID, e.g., -S w.07 (all WPACTCs in 2007)
- DTG range, e.g., all TCS from 2007090700-2007093000
- comp 9Xdev v 9Xnon
- list variables, e.g., VWS in .csv

- Quality of ERA5 forecasts – how good are the dynamics like vertical wind shear?
 - ▶ ABBY results suggest the analyses are ‘good’ and of consistent quality 1979-present
 - ▶ I have ERA5 forecasts for Halsey’s typhoon Cobra 19441215 – best track?
- Formation or 9X → NN
 - ▶ rate or percentage of 9X that become NN
 - ▶ difference in dynamics (vertical wind shear) & thermo (3deg mean rain) between 9Xdev and 9Xnon
- Version 1.0
 - ▶ add 2006 & 2023
 - ▶ add more R34 data from CIRA & ERA5

“Forecasting is the acid test of an analysis”

Bob Kistler, NCEP

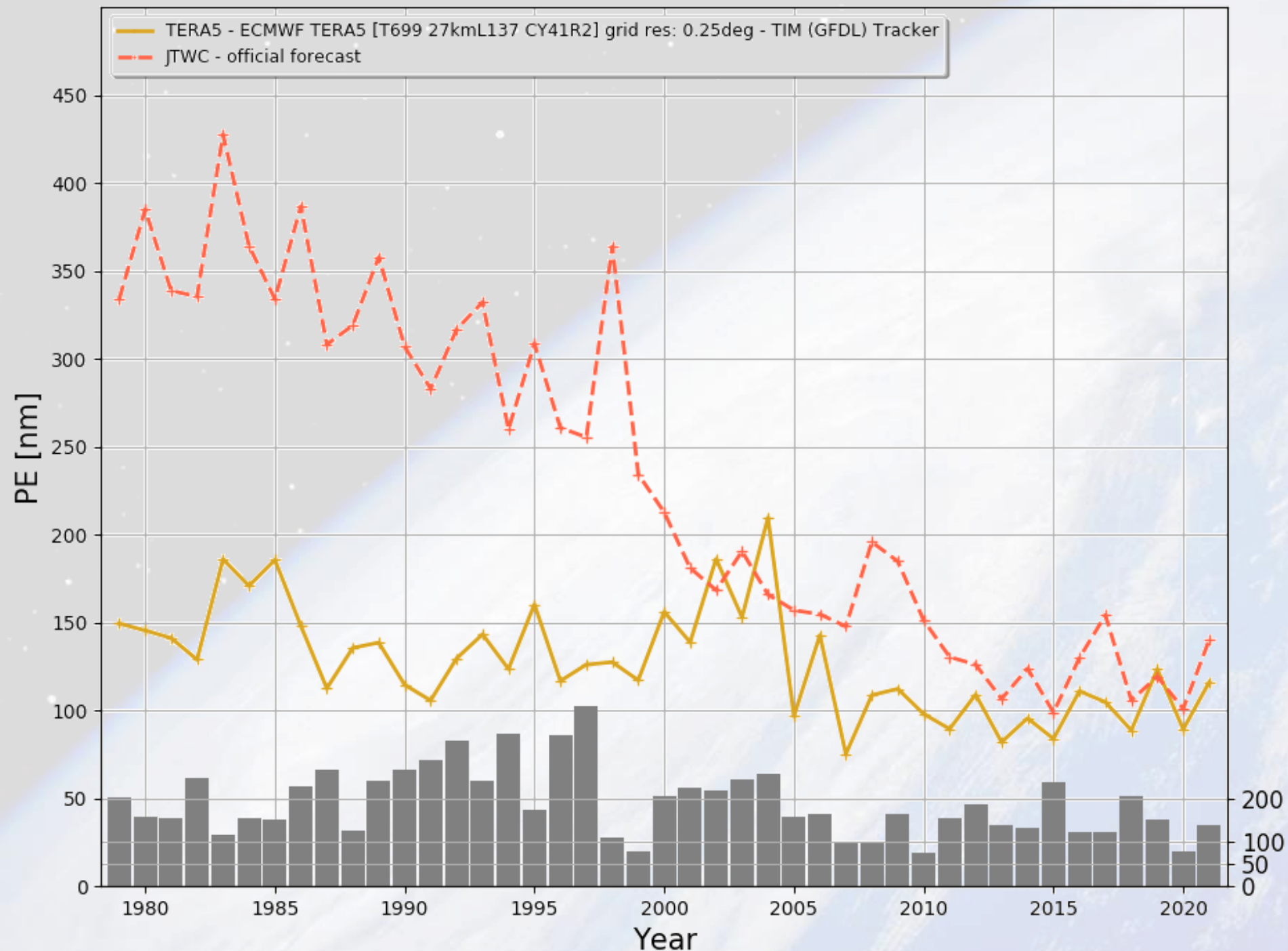
father of American Reanalysis

NCEP/NCAR R1

WPAC ERA5 v JTWC mean 72-h PE 1979-2021

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WPAC tau=72 h mean PE ERA5 v JTWC

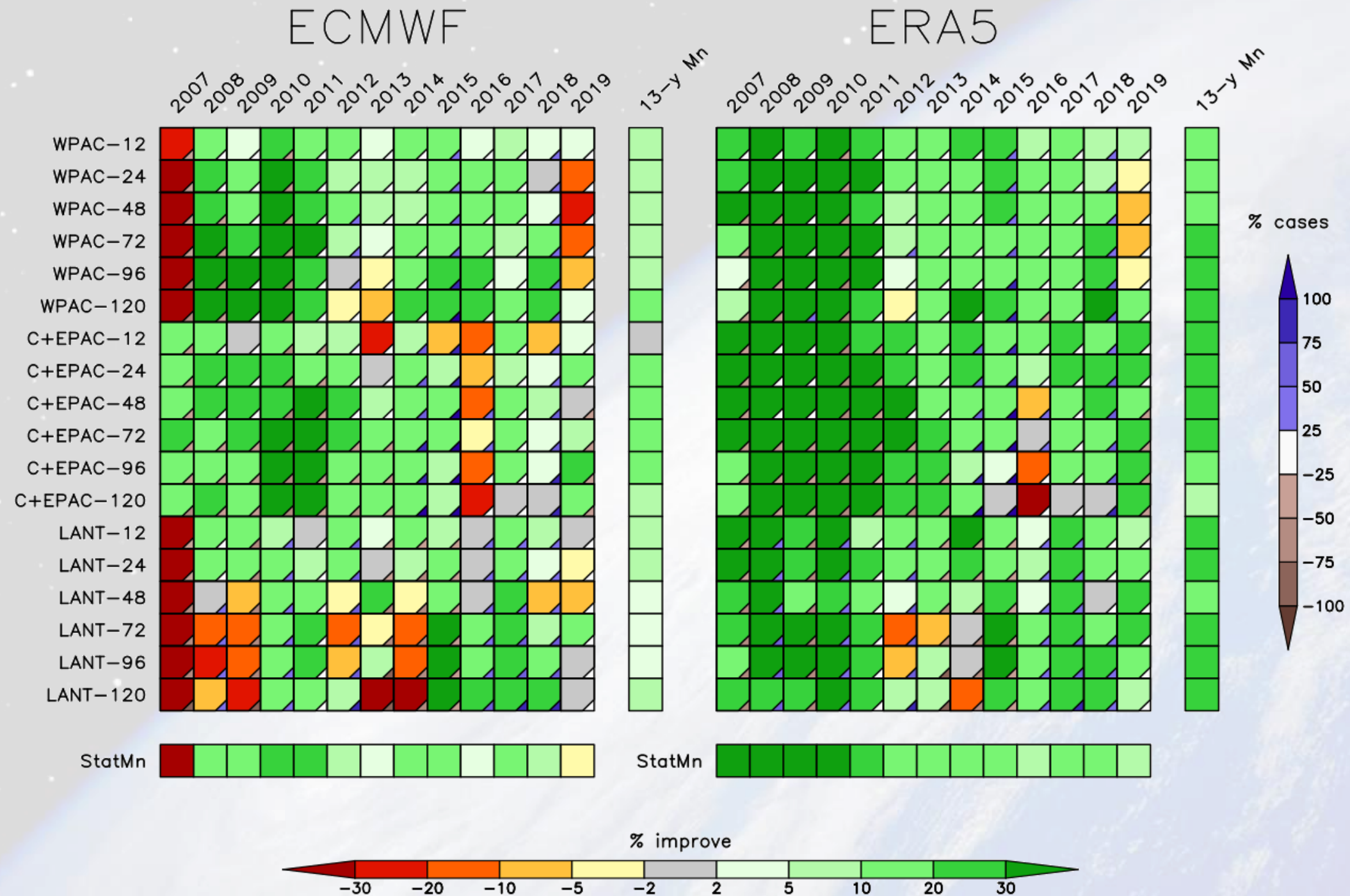


ECMWF v ERA5 v GFS 2007-2019

% improve (lower) mean PE relative to GFS as a baseline

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ECMWF/ERA5 Mean Position Error %improve over GFS [%]

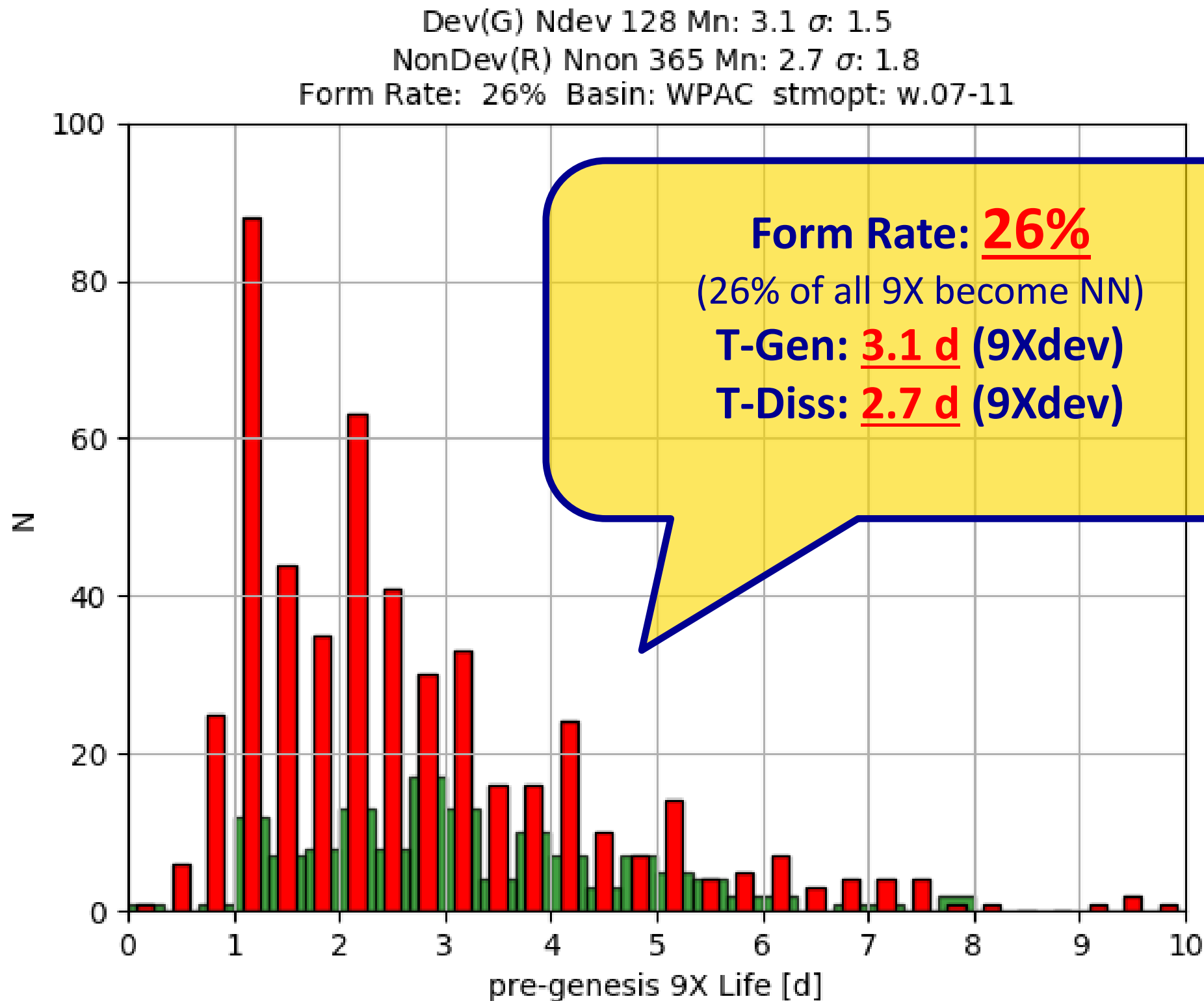


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Formation Rate & Time to Genesis/Dissipation

WPAC 2007-2011

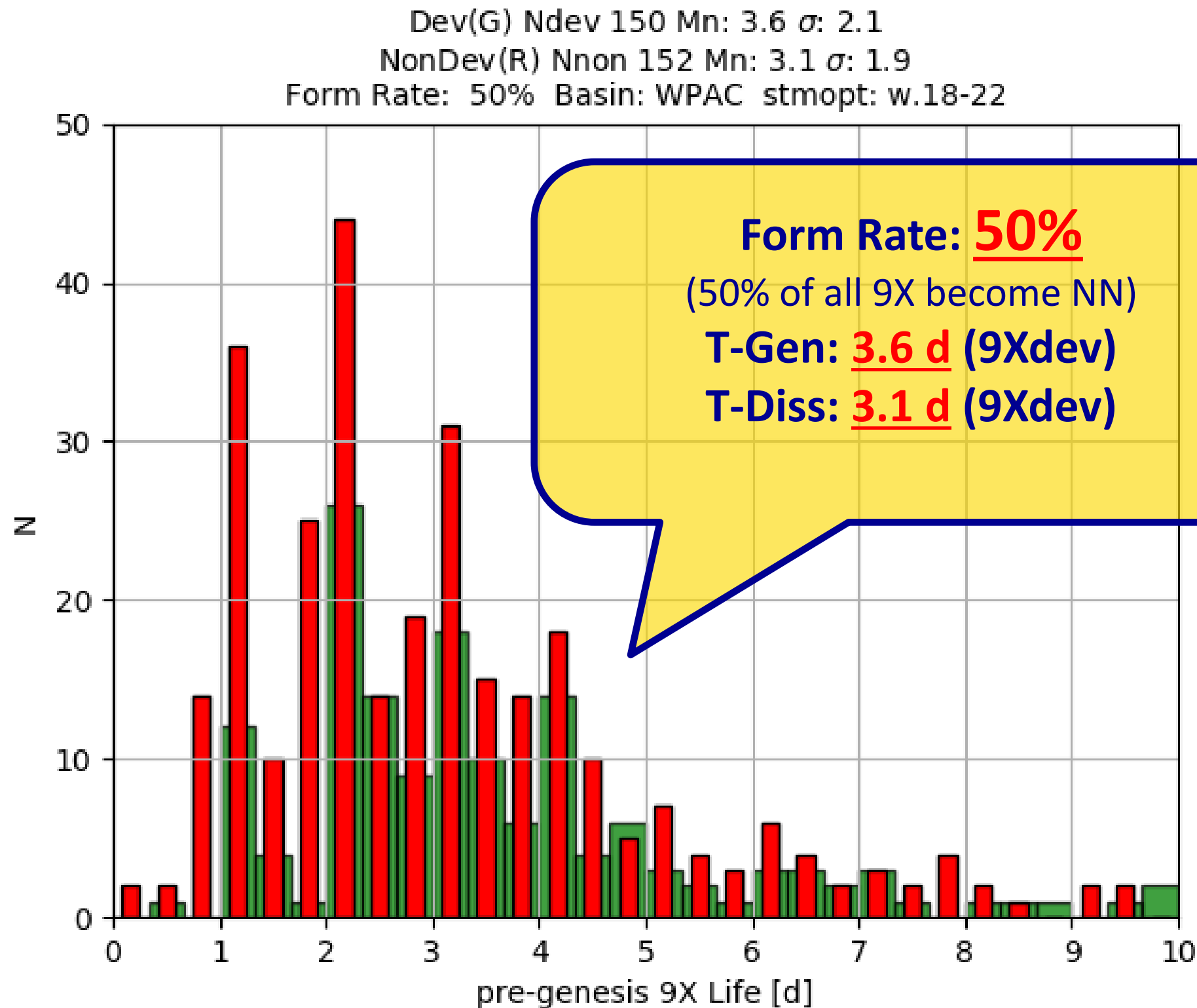
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Formation Rate & Time to Genesis/Dissipation

WPAC 2018-2022

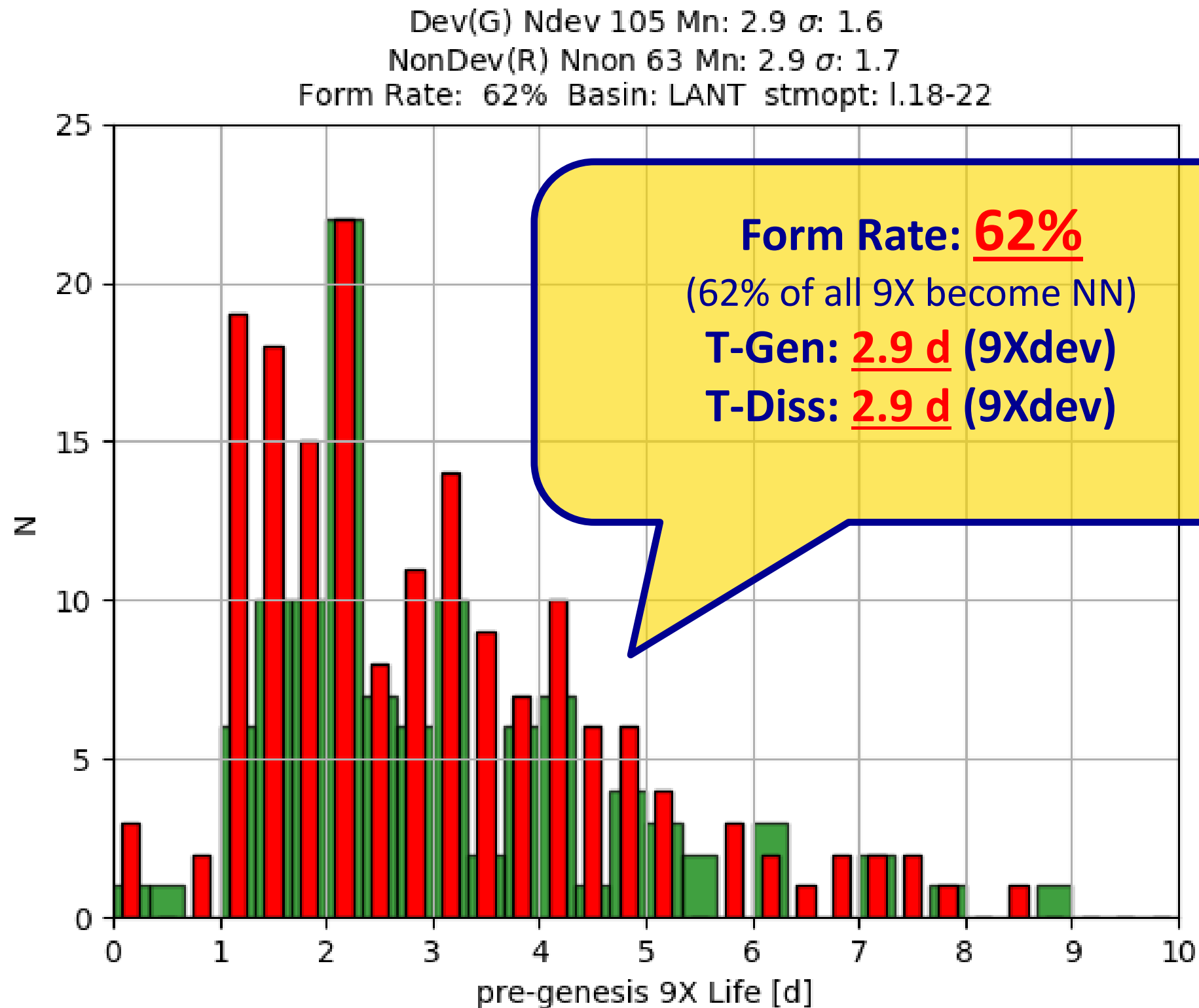
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Formation Rate & Time to Genesis/Dissipation

LANT 2018-2022

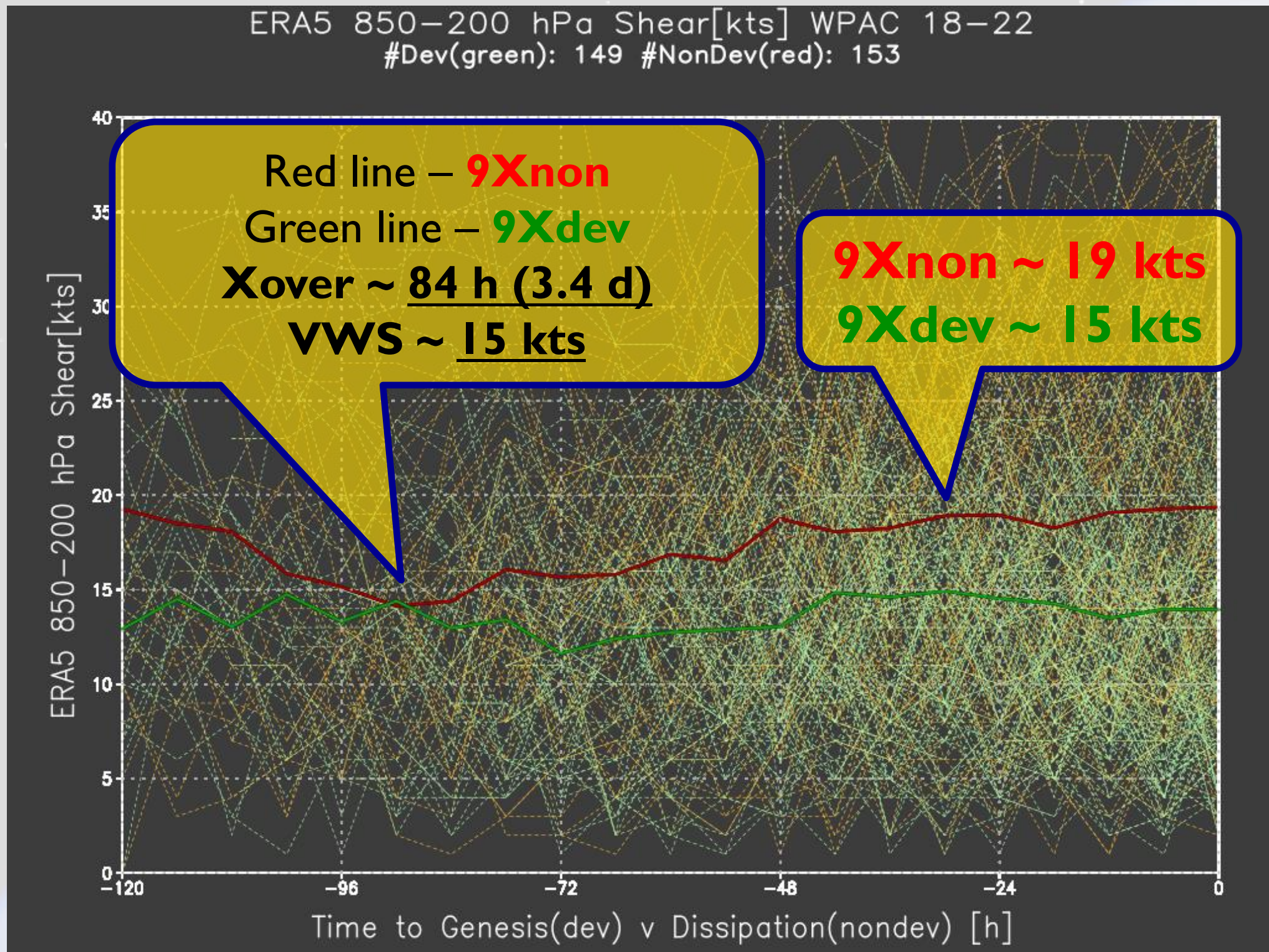
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- Quality of ERA5 forecasts – how good is the dynamics like vertical wind shear?
 - ▶ ABBY results suggest the analyses are ‘good’ and of consistent quality 1979-present
- Formation or 9X → NN
 - ▶ rate or percentage of 9X that become NN
 - ▶ difference in dynamics (vertical wind shear) & thermo (300 km mean rain) between 9Xdev and 9Xnon
- Version 1.0
 - ▶ add 2006 & 2023
 - ▶ add more R34 data from CIRA & ERA5

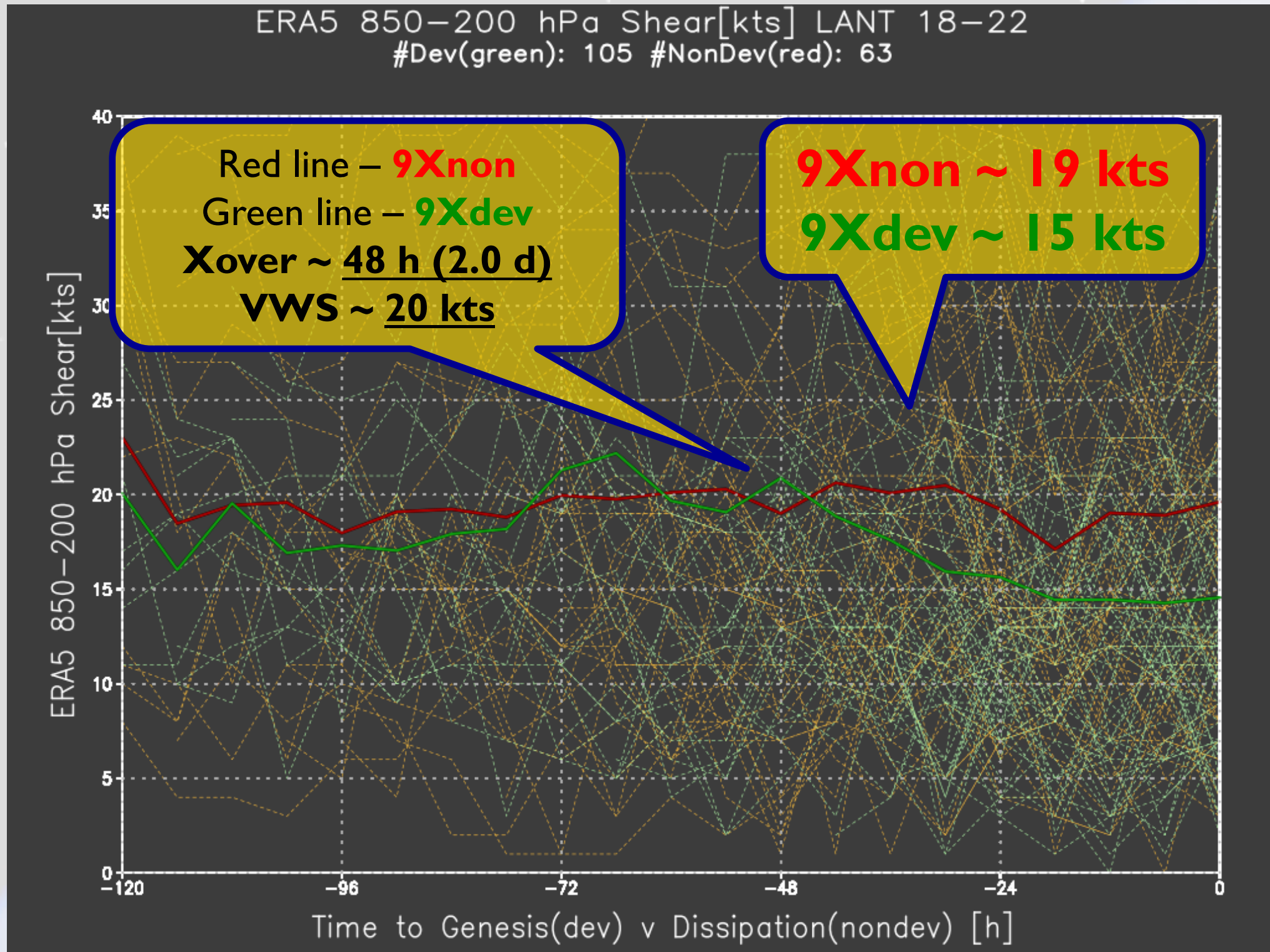
Vertical Wind Shear – diff between 9Xdev & 9Xnon WPAC 2018-2022

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Vertical Wind Shear – diff between 9Xdev & 9Xnon LANT 2018-2022

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Vertical Wind Shear – diff between 9Xdev & 9Xnon summary for 5-y period 2018-2022

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- WPAC

- ▶ 9Xdev v 9Xnon begin to depart or **Xover point ~ 3 d**
- ▶ **VWS ~ 15 kts** & lower than in the LANT
- ▶ both 9Xdev & 9Xnon start at 15 kts but 9Xnon increases to 19 kts

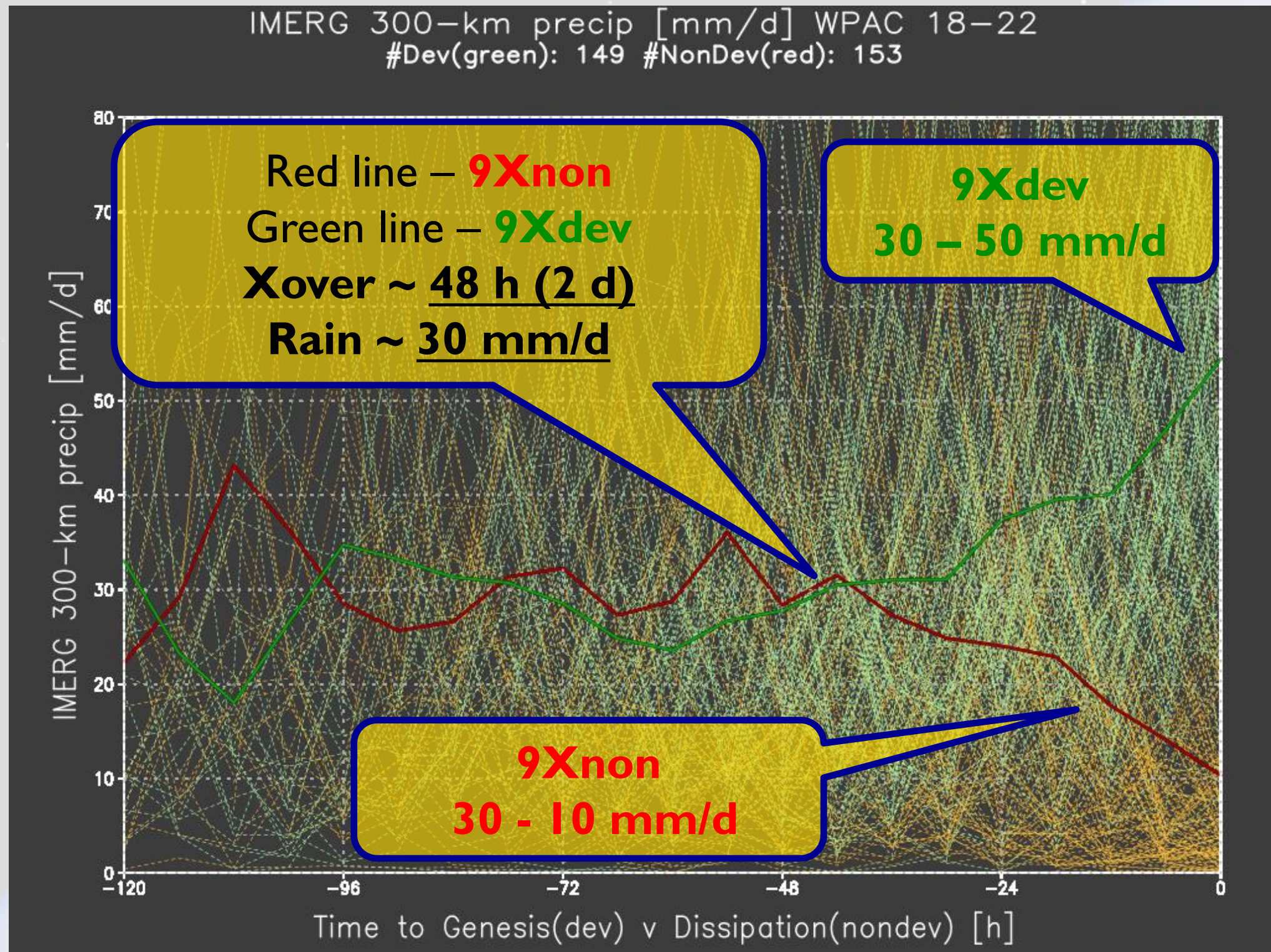
- LANT

- ▶ 9Xdev v 9Xnon begin to depart or **Xover point ~ 2 d**
- ▶ **VWS ~ 20 kts** & higher than in WPAC

- Quality of ERA5 forecasts – how good is the dynamics like vertical wind shear?
 - ▶ ABBY results suggest the analyses are ‘good’ and of consistent quality 1979-present
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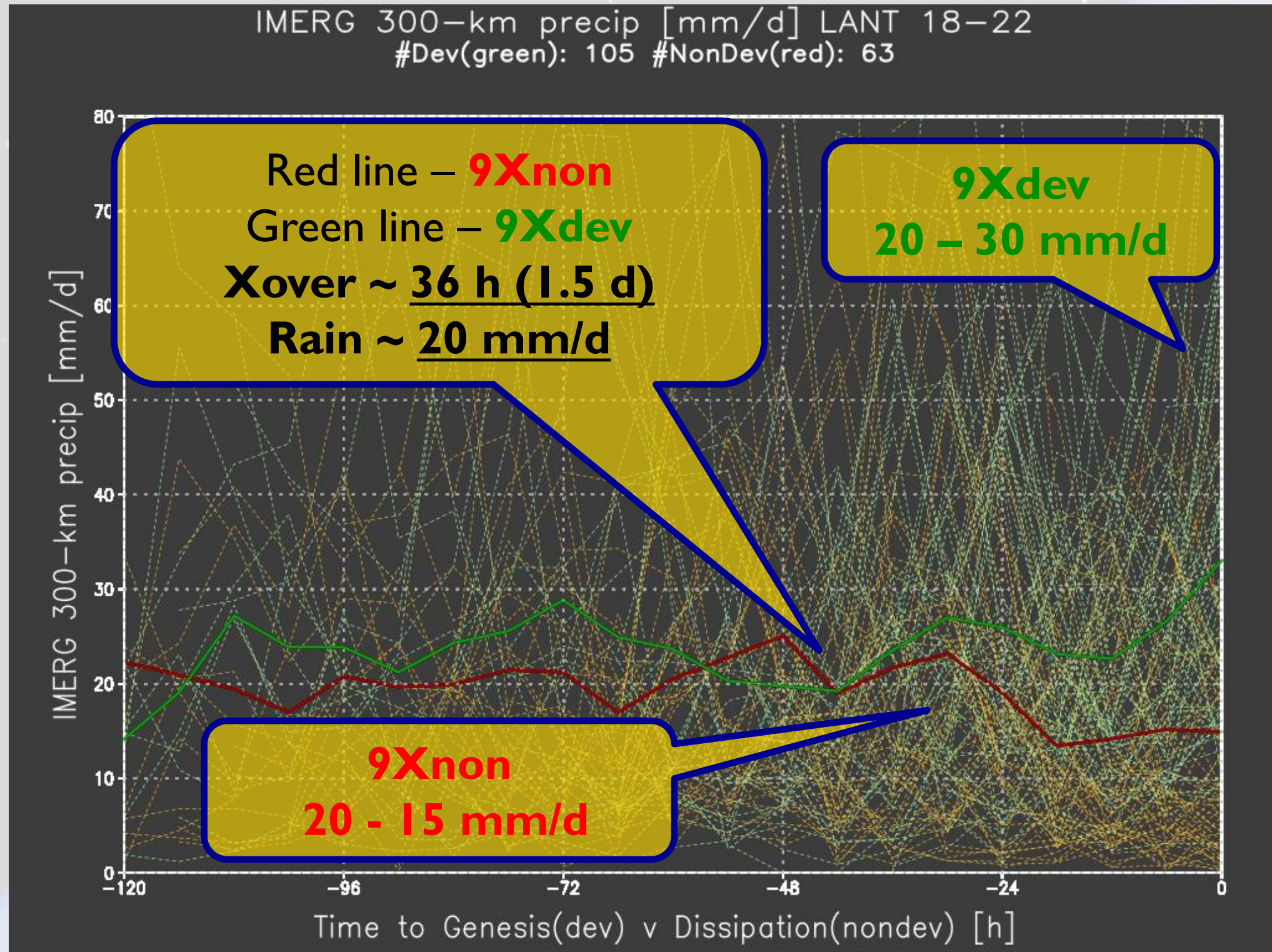
IMERG 300 km rainrate [mm/d] – diff between 9Xdev & 9Xnon WPAC 2018-2022

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IMERG 300 km rainrate [mm/d] – diff between 9Xdev & 9Xnon LANT 2018-2022

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- WPAC

- ▶ 9Xdev v 9Xnon begin to depart or **Xover point ~ 2 d**
- ▶ **RR ~ 30 mm/d** & **higher** than in the LANT
- ▶ both 9Xdev & 9Xnon start at 30 mm/d but 9Xnon **decreases** to 15 mm/d

- LANT

- ▶ 9Xdev v 9Xnon begin to depart or **Xover point ~ 1.5 d**
- ▶ **RR ~ 20 mm/d** & **lower** than in WPAC
- ▶ RR change ~ 10 mm/d vice 15-20 mm/d in WPAC

- **Formation Rate or 9X → NN**
 - ▶ substantial increase in JTWC/WPAC 2007 – 2022
 - 9X is no-cost to the TDO
 - current TDO/HS at both JTWC & NHC are more consistent in identifying ‘significant’ disturbances
 - ▶ highest formation rate is in EPAC lowest in SHEM
- **VWS**
 - ▶ higher in the LANT (~20 kts); lower in WPAC (~15 kts)
 - ▶ Xover point longer in WPAC (3.5 d) v LANT (2.0 d)
- **Rain**
 - ▶ WPAC higher (~30 mm/d) v LANT (~20 mm/d)
 - ▶ Xover point longer in WPAC (2.0 d) v LANT (1.5 d)

Takeaways

and an answer to Bill Gray's Question ...

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- the superBT adds three unique and high-quality data sets to existing Best Tracks
 - ▶ 1979-2024 – ERA5 2X daily 10-d forecasts
 - ▶ 1999-2024 – NASA IMERG hi-res, nearly-global precipitation
 - ▶ 2006-2024 – curated 9Xdev & 9Xnon
- Shown unique differences in both VWS and rain rate between 9Xdev and 9Xnon
- V04 at <https://github.com/tenkiman/superBT-V04/>
- V1.0 – add TC size – my bigger interest
 - ▶ 2006 & 2023 (from 17 y to 19 y)
 - ▶ R34 from best track + CIRA + R34/POCI from ECMWF IFS & ERA5

URL	Data/Doc/Web
https://github.com/tenkiman/superBT-V04	V04 github repo and starting README
https://github.com/tenkiman/superBT-V04/releases/tag/V04.01	1 st release as .zip or tar.gz files
https://github.com/tenkiman/superBT-V04/blob/main/docs/README-sbt-v04.md	detailed README of the 1 st github
https://surperbt.blogspot.com/2023/12/intro-to-superbt.html	superBT blog with introduction to the superBT and results
https://maps.wxmap2.com/	WxMAP2 originally developed at JTWC 2002-2005
https://jtdiag.wxmap2.com/	JTDIAG to display ‘diagnostic file’ for real-time forecasting
https://tcgen.wxmap2.com/	TC genesis

Mahalo

どうも
ありがとう
ございました