Creating Vector Winds from Simulated CYGNSS Ocean Surface Wind Speed Retrievals Using Variational Analysis

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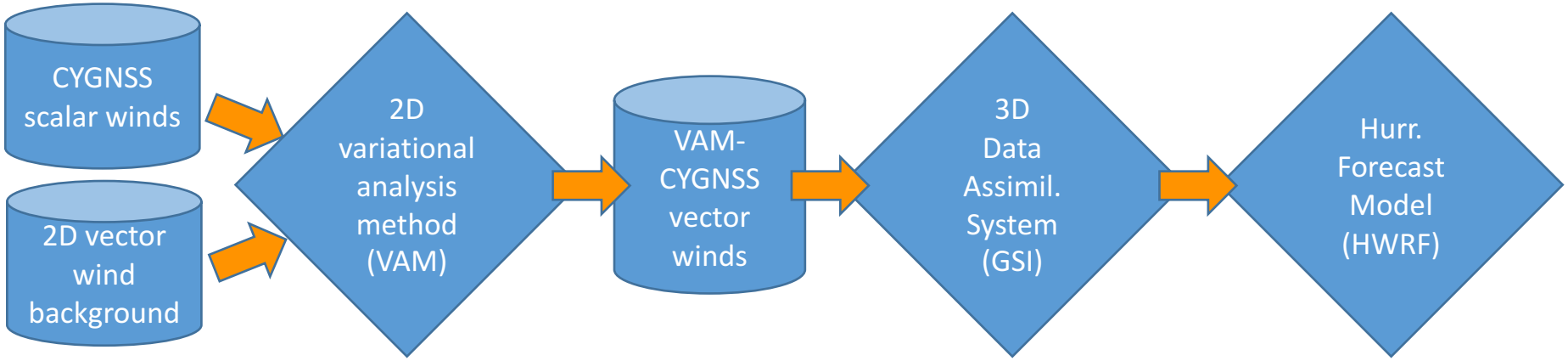
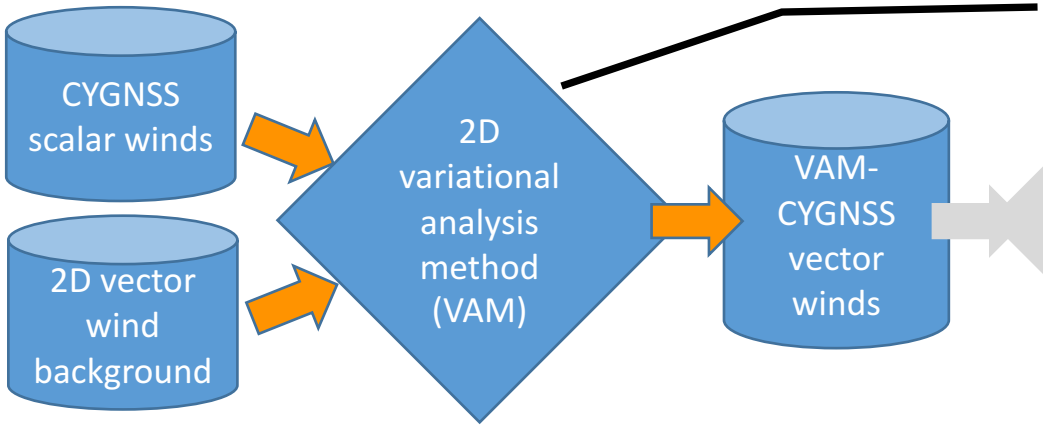
Introduction / Motivation

- CYGNSS will provide scalar wind retrievals (more detail in next talk)
- But could we have wind *vectors* at CYGNSS obs locations?
- A potential path is explored:



Introduction / Motivation



VAM has been used to generate 30 years of 6-hourly global ocean wind analyses: Cross-calibrated Multiplatform (CCMP) data set @ JPL, (V1.1) and RSS (V2.0).

R. Atlas *et al.*, 2011: A Cross-calibrated, Multiplatform Ocean Surface Wind Velocity Product for Meteorological and Oceanographic Applications. *Bull. Amer. Meteor. Soc.*, **92**, 157–174, doi: 10.1175/2010BAMS2946.1.

- VAM finds an optimal fit to wind observations, given a 1st guess wind vector field

$$J(x) = J_b(x) + J_o(x) + J_c(x)$$

The VAM creates gridded 2D surface wind vector analysis by minimizing an objective function, J, which measures the misfit of the analysis to the background (J_b), the observations (J_o), and a priori constraints (J_c)… the analyzed dynamical balance must be close to that of the background.

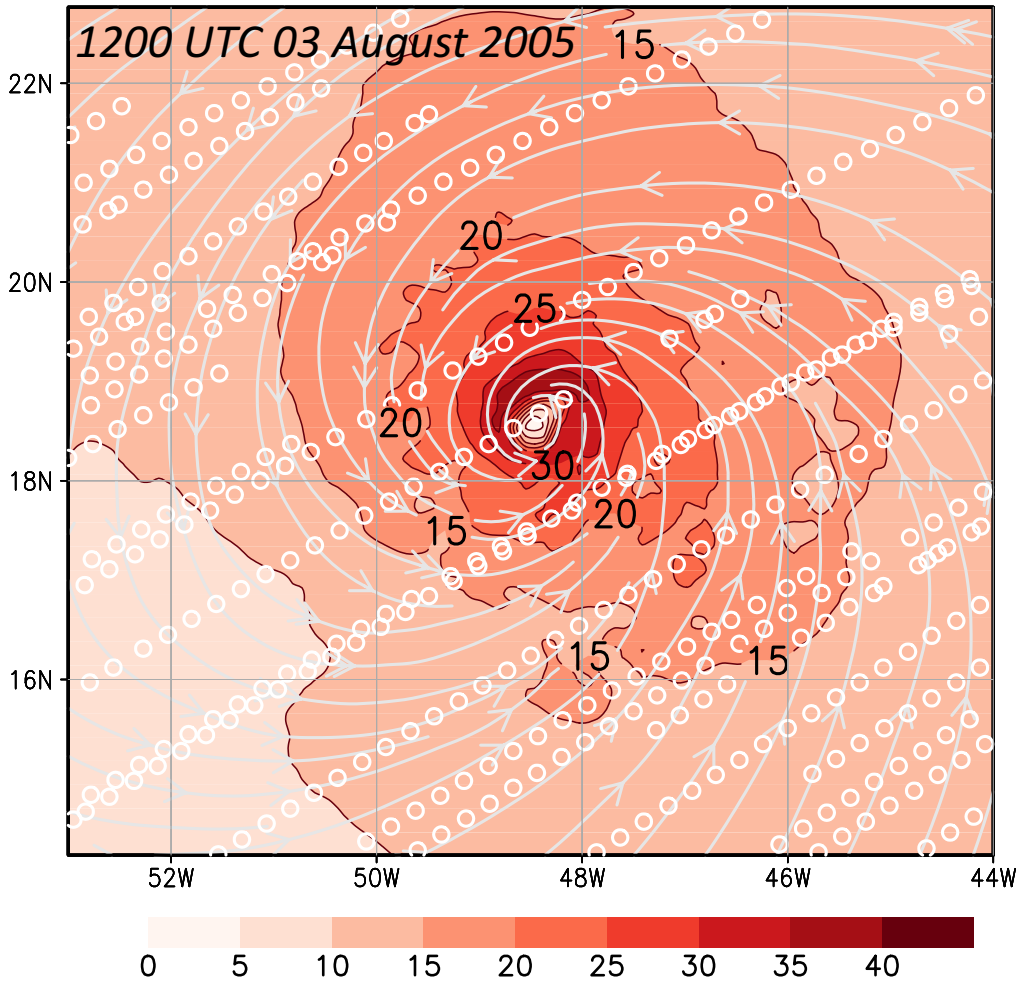
Simulation of CYGNSS wind retrievals

UM/AOML Nature Run 10-meter winds (Nolan et al. 2013)

Simulated using the CYGNSS Science Team End-to-End Simulator (E2ES).

Uses the Univ. of Miami/ AOML WRF-ARW hurricane Nature Run (UM/AOML NR).

Expected CYGNSS observation errors are applied.



Nolan, D. S., R. Atlas, K. T. Bhatia, and L. R. Bucci, 2013: Development and validation of a hurricane nature run using the joint OSSE nature run and the WRF model, J. Adv. Model. Earth Syst., 5, 382–405, doi:10.1002/jame.20031.

UM/AOML NR

10-m winds and
Simulated CYGNSS obs

VAM Backgrounds

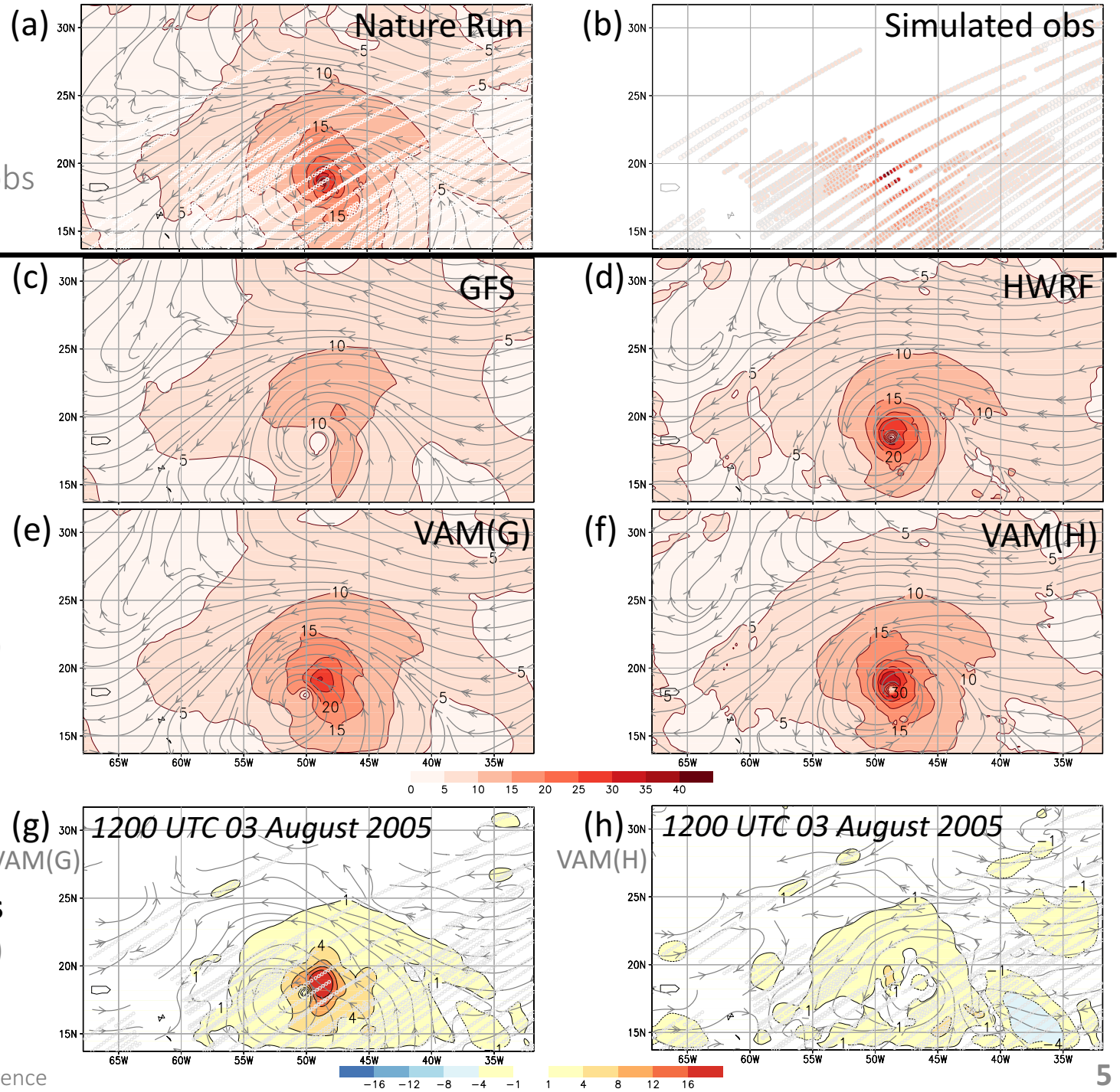
GFS and HWRF
(6-hour forecasts)

VAM Analyses

VAM(G) and VAM(H)

Analysis Increments

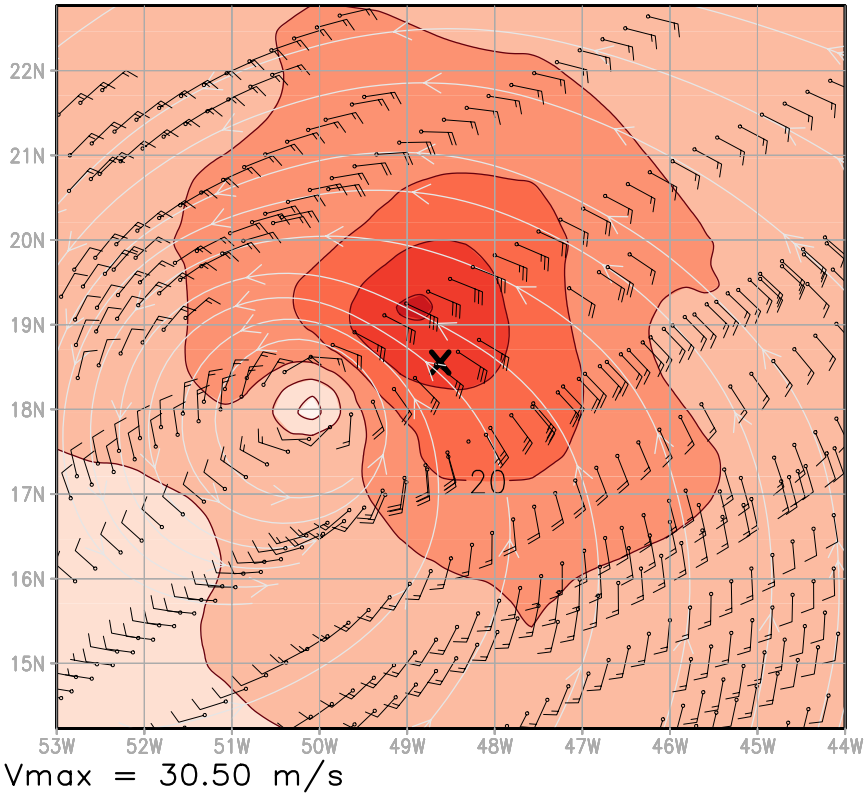
VAM(G) and VAM(H)



VAM Analyses

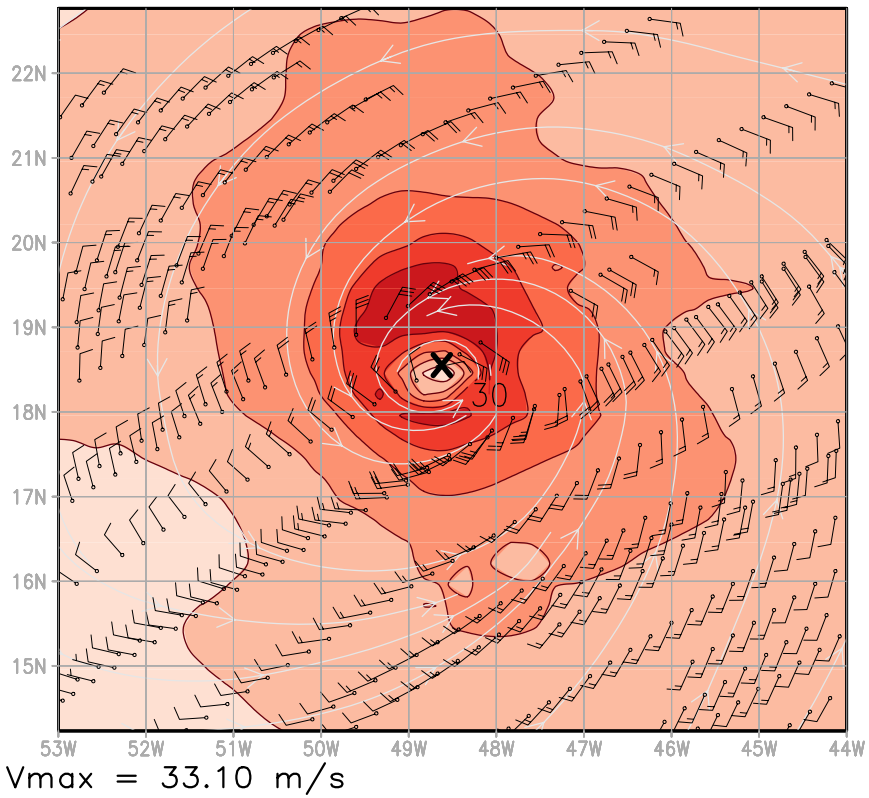
1200 UTC 03 August 2005

(a) VAM(G) analysis

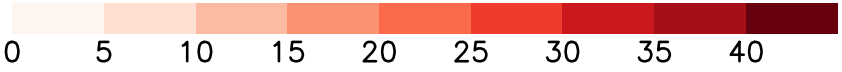


Vmax = 30.50 m/s

(b) VAM(H) analysis

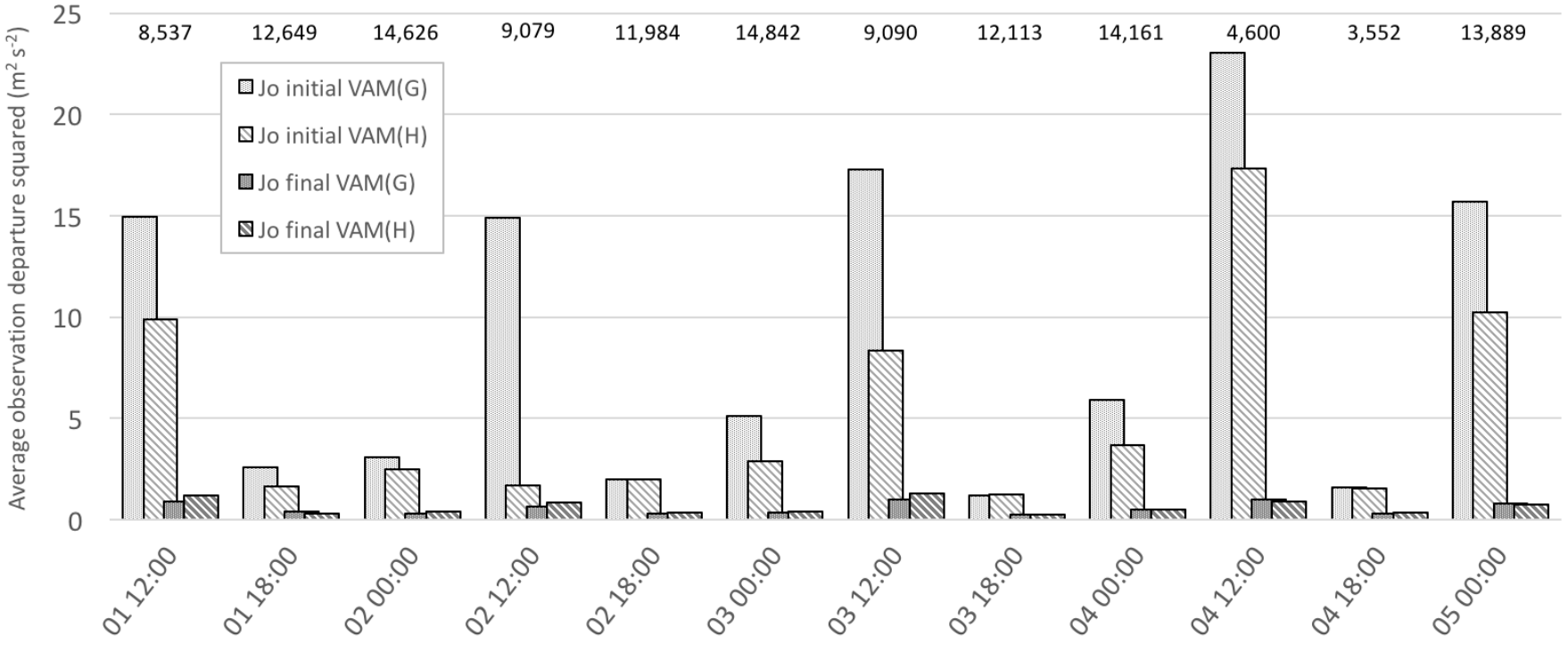


Vmax = 33.10 m/s

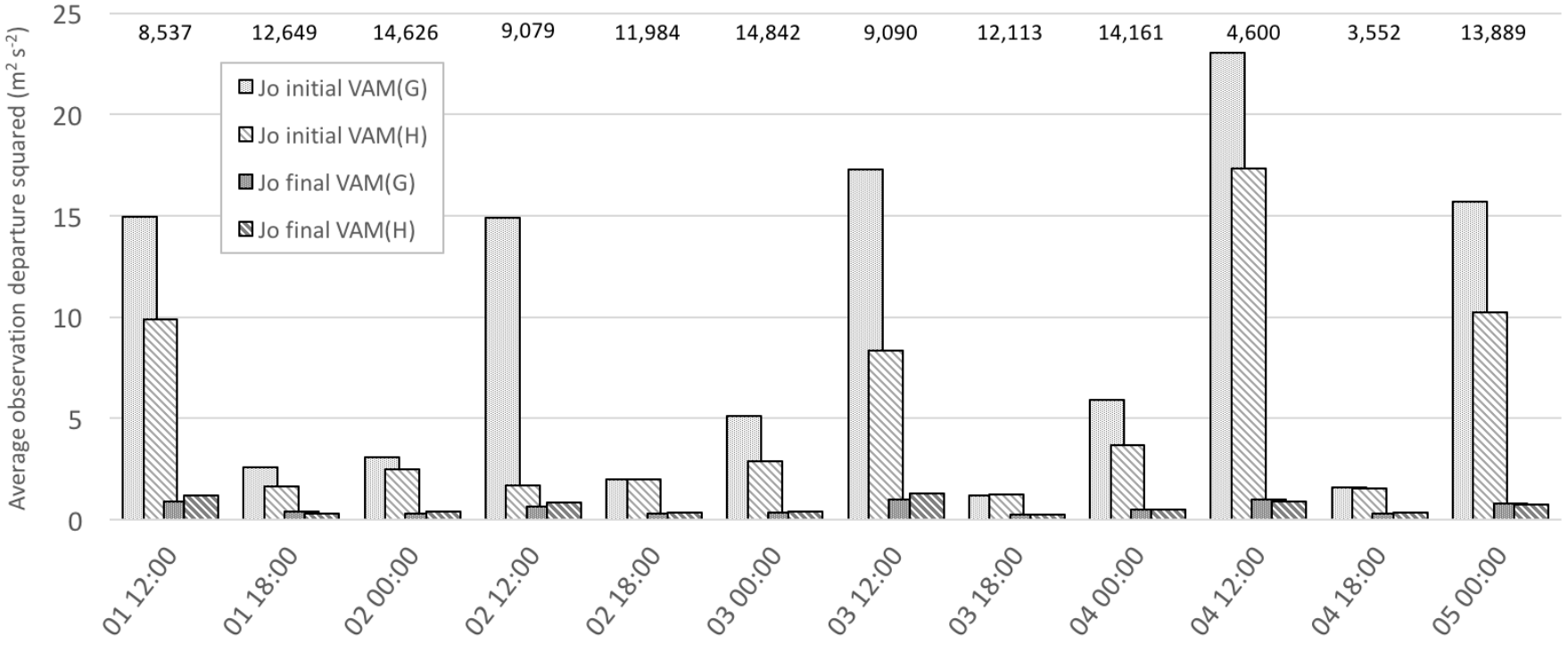


X = Nature Run position

CYGNSS observation fits in the VAM

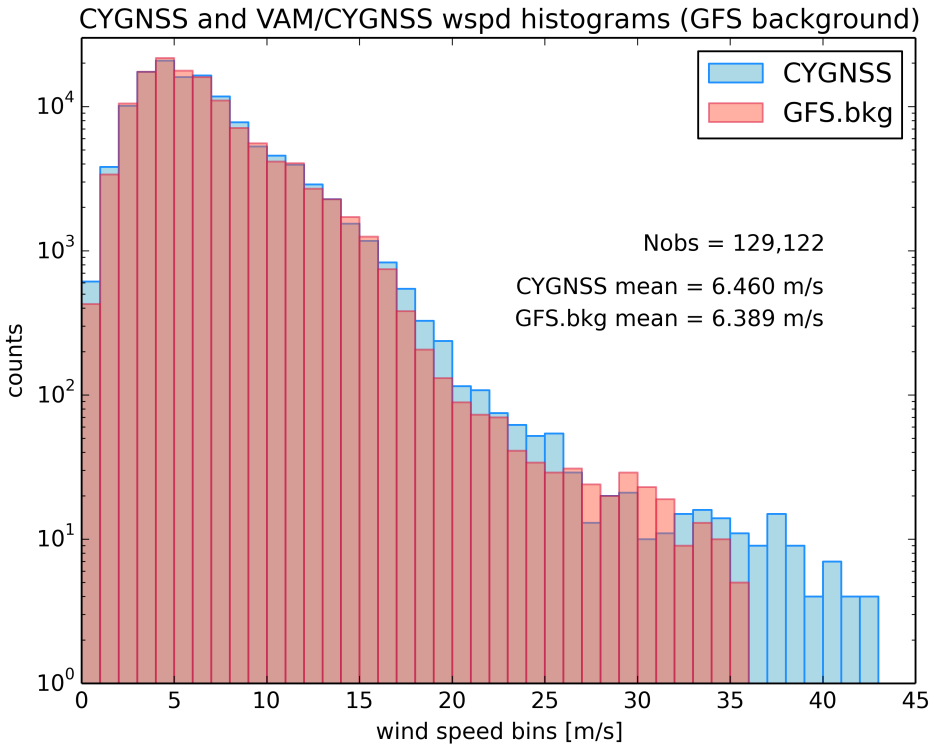


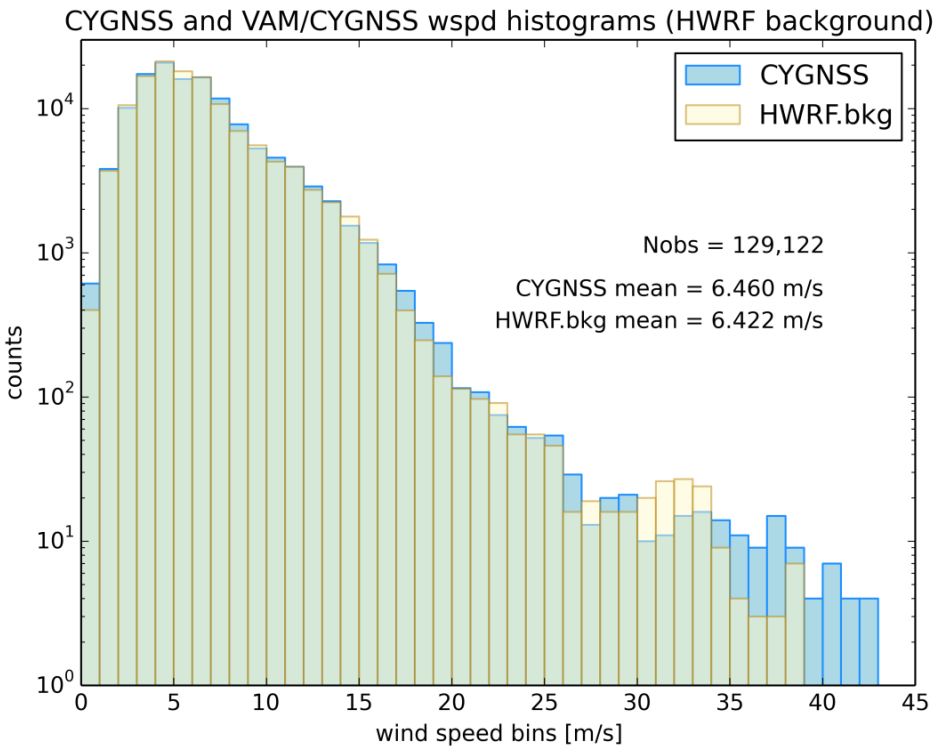
CYGNSS observation fits in the VAM



Overall statistics	GFS backgrounds	HWRF backgrounds
RMS o-b *stddev* [m/s]	**1.48** *0.66*	**1.14** *0.50*
RMS o-a *stddev* [m/s]	**0.41** *0.10*	**0.43** *0.11*

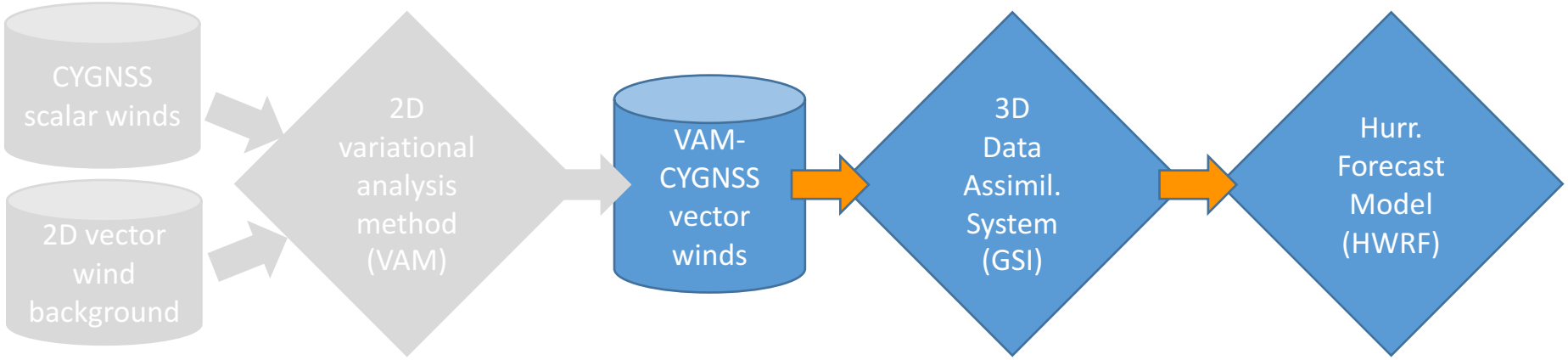
CYGNSS wind speed histograms





CYGNSS Observing System Simulation Experiments (OSSEs) with HWRF

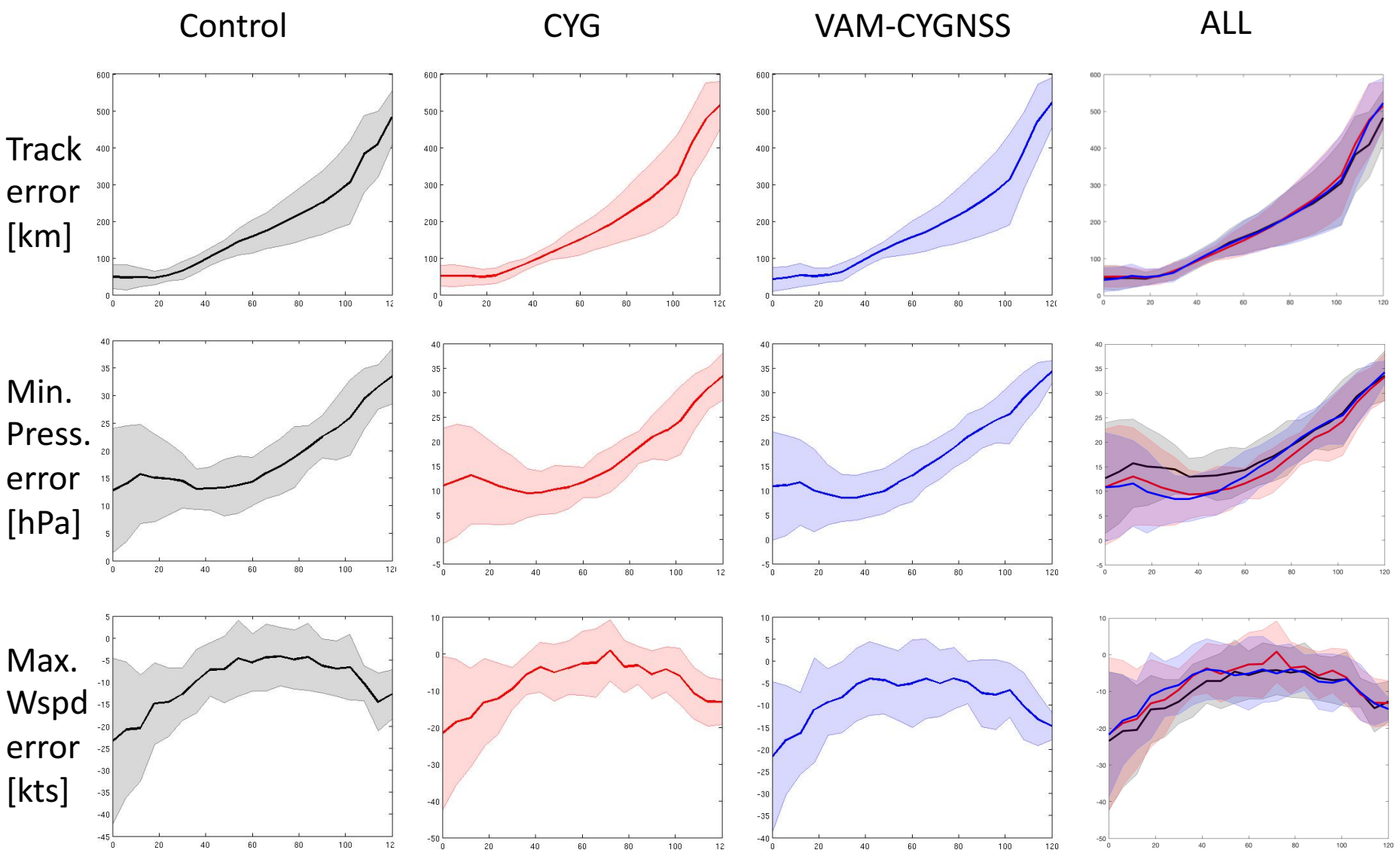
- HWRF OSSEs performed to assess CYGNSS impact (full details in next talk)
- A subset of results presented here – scalar vs. vector



- Three OSSE DA treatments:
  - Control = the NCEP suite of conventional & satellite observations
  - CYG = Control + CYGNSS scalar winds
  - VAM-CYGNSS = Control + CYGNSS vector winds

HWRF CYGNSS OSSE results

0600 UTC 02 August - 0000 UTC 05 August 2005 *N=12 forecasts*

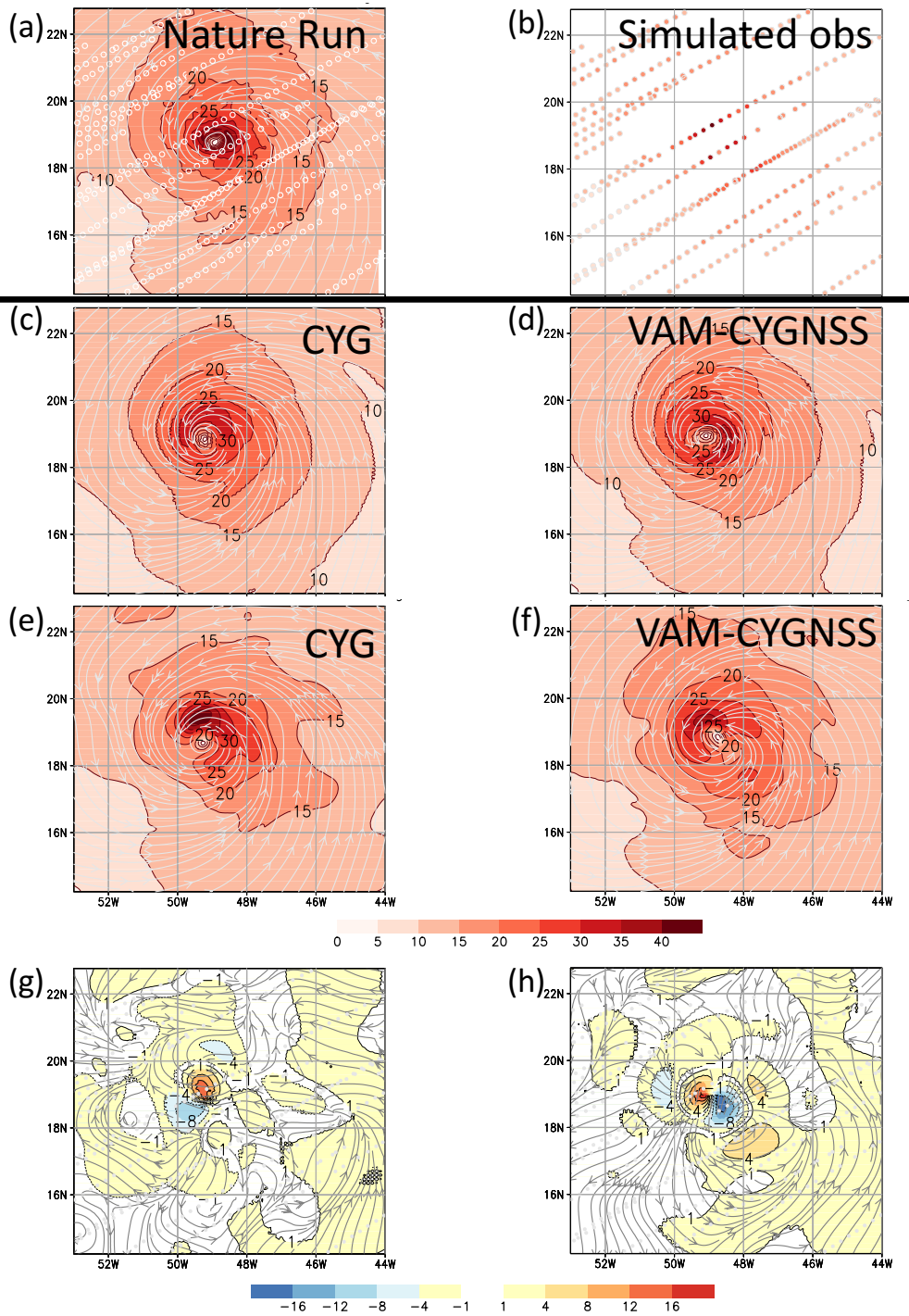


UM/AOML NR
10-m winds and
Simulated CYGNSS obs

GSI Backgrounds
CYG and VAM-CYGNSS
(3-hour forecasts)

GSI Analyses
CYG and VAM-CYGNSS

GSI Analysis Increments
CYG and VAM-CYNGSS



1500 UTC
03 August 2005

Summary and Conclusions

- CYGNSS will observe tropical cyclones globally with periodic revisit times
- Vector information is more valuable to assimilation systems
- The Variational Analysis Method (VAM) is an approach to generate CYGNSS winds with vector information
- VAM analysis results dependent on the choice of background
  - Higher-resolution backgrounds are more suitable than lower-resolution backgrounds
- OSSE results show the value added by using vector CYGNSS
  - Improved analysis of wind field structure & storm location
  - Improved intensity forecasts (maximum wind speed & min. pressure)
- Pre-processing of CYGNSS winds to VAM-CYGNSS, and assimilation, will occur during the 2017 hurricane season

Thank you.

Questions?

Preview -- the next talk will describe CYGNSS and HWRF CYGNSS OSSEs in more detail.