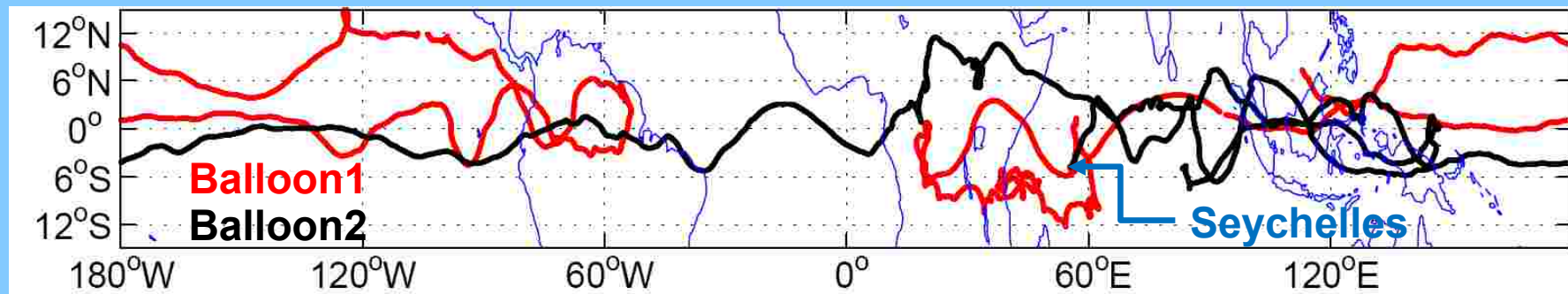


Accuracy of analyses in the equatorial lower stratosphere during PreConcordiasi

Aurélien Podglajen (apodgla@lmd.ens.fr), Albert Hertzog, Riwal Plougonven, LMD, Ecole Polytechnique, Palaiseau, France

Nedjeljka Zagar, University of Ljubljana



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RESEARCH ARTICLE

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Assessment of the accuracy of (re)analyses in the equatorial lower stratosphere

Key Points:

Aurélien Podglajen¹, Albert Hertzog¹, Riwal Plougonven¹, and Nedjeljka Žagar²

(Re)-analyses used

- **MERRA**

 - 3D VAR

 - 72 vertical levels (5 between 100 et 40 hPa)

- **ECMWF operational analysis**

 - 4D VAR

 - 91 vertical levels (10 between 100 et 40 hPa)

- (ERA interim)

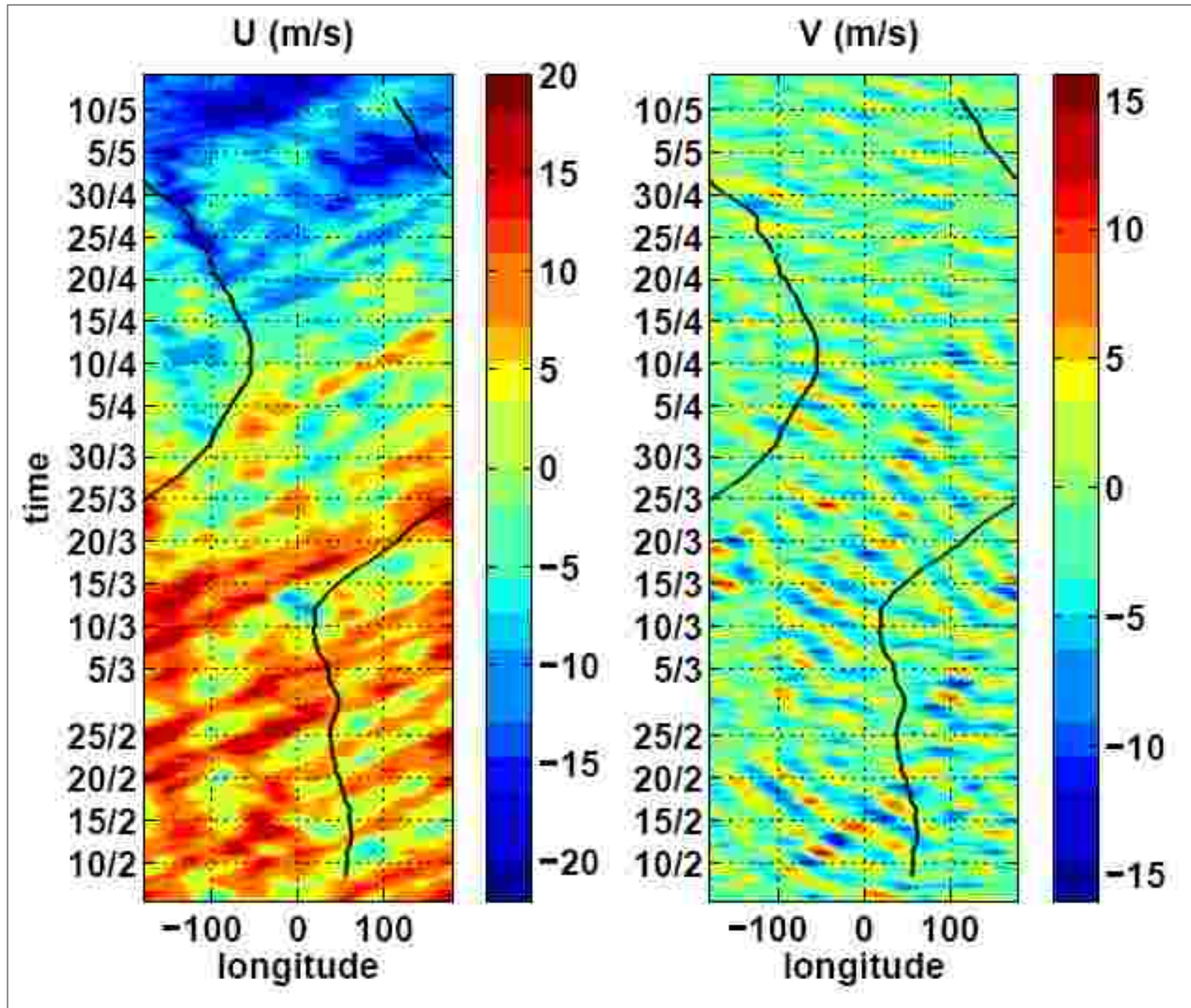
 - 4D VAR

 - 60 vertical levels (5 between 100 et 40 hPa)

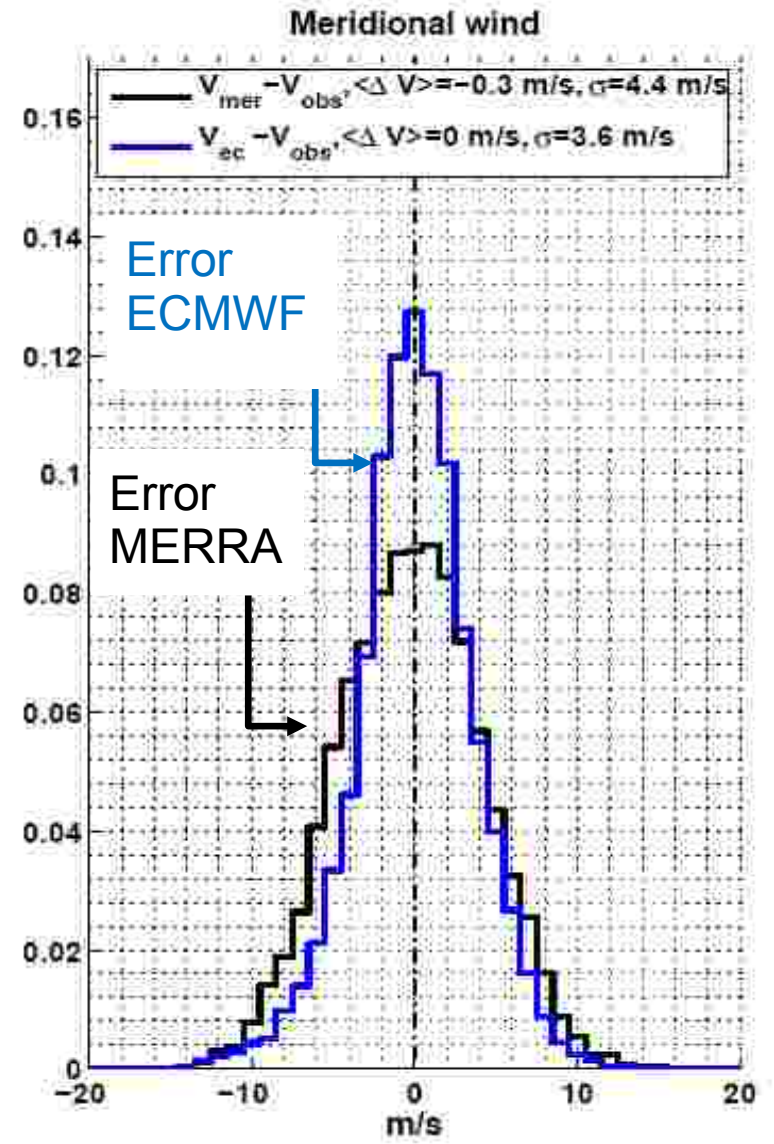
Dynamical context

Hövmoller diagrams
at 57 hPa **at the
equator** (in the
ECMWF analysis)

and 'trajectory' of
balloon #1

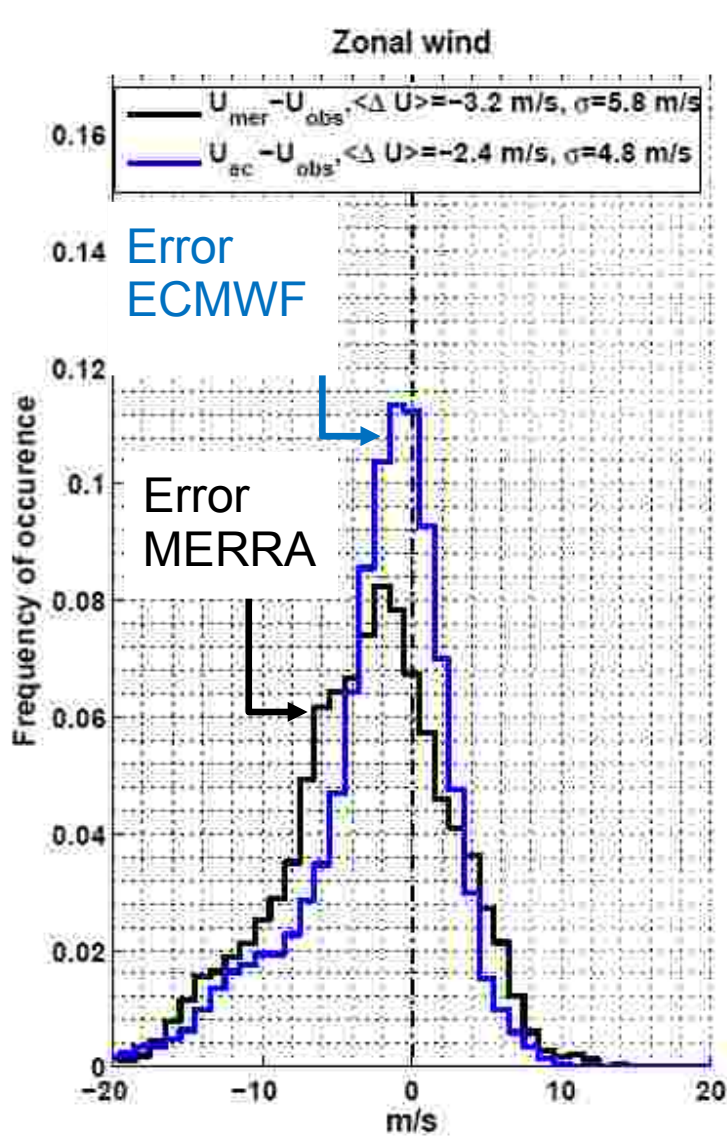


Analyses error statistics

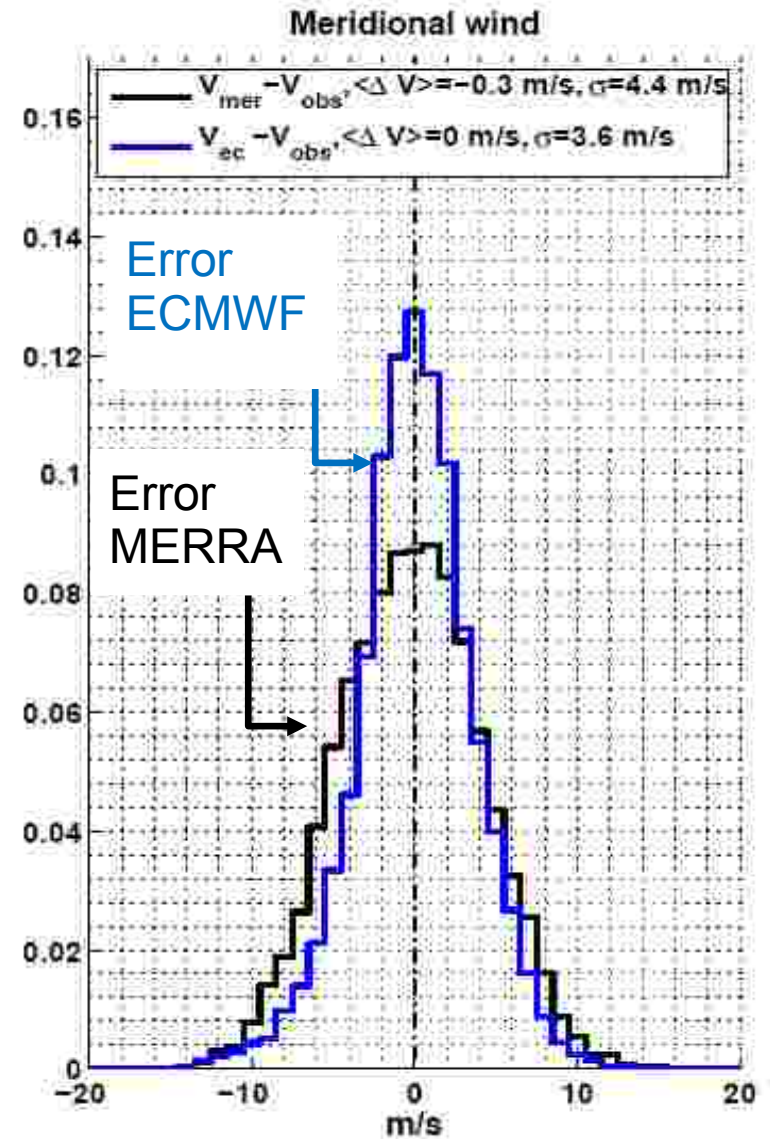


V

Analyses error statistics



U

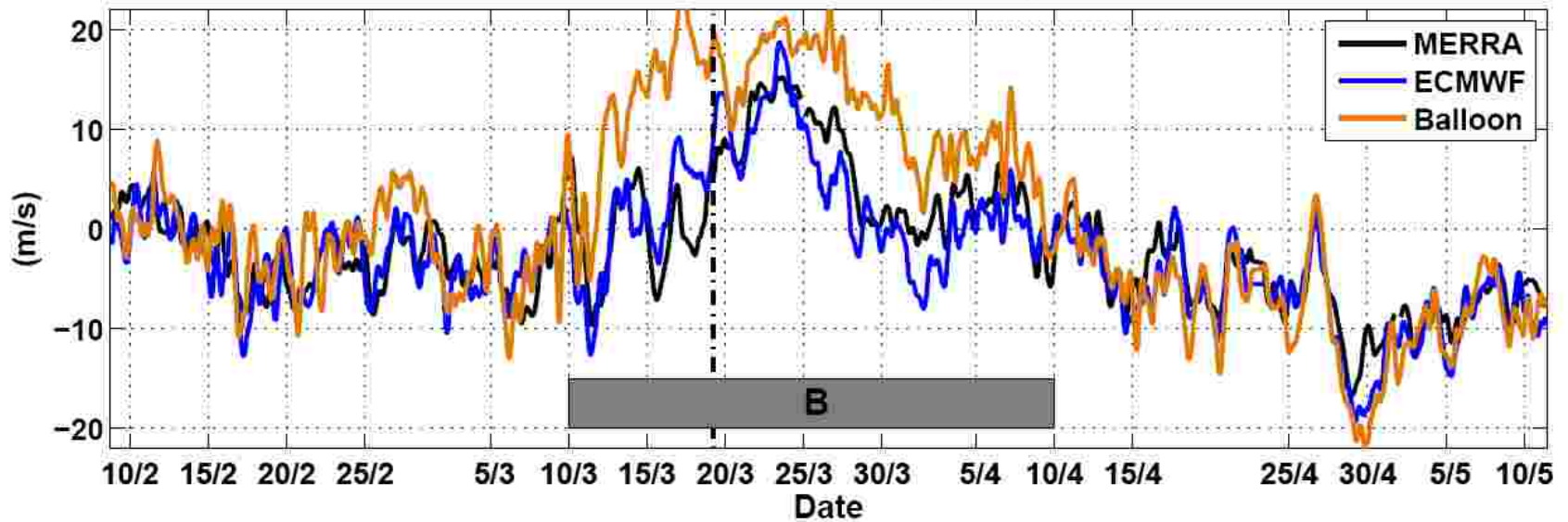


V

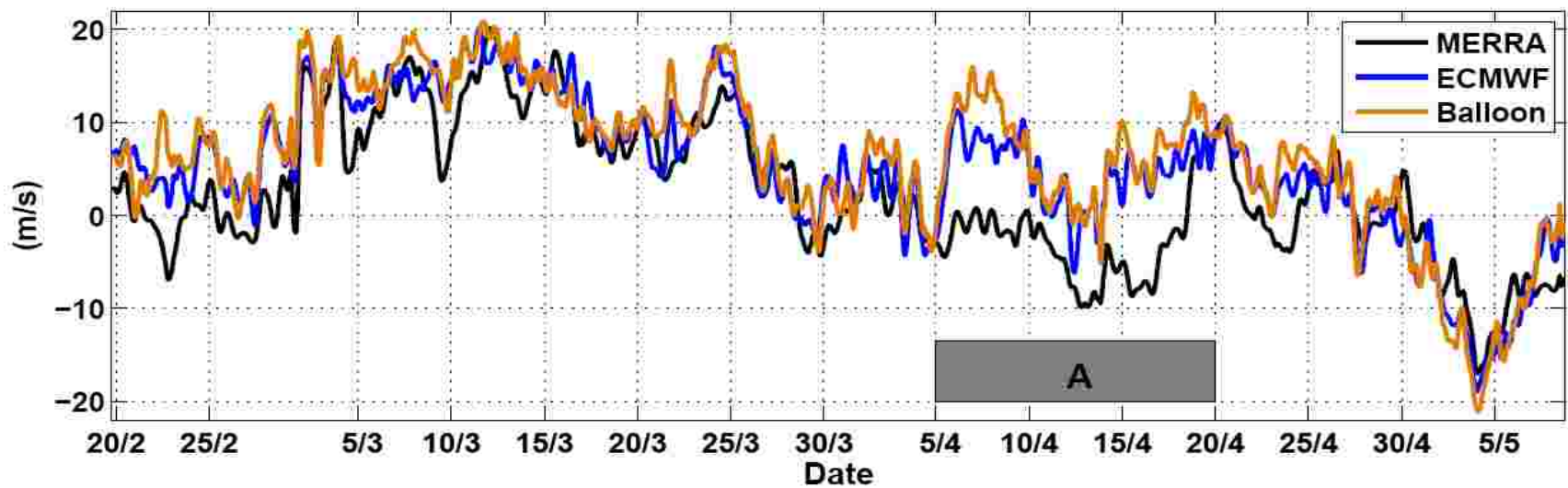
Time structure of the errors

Errors happen during **limited but long-lasting time periods**

U balloon 1

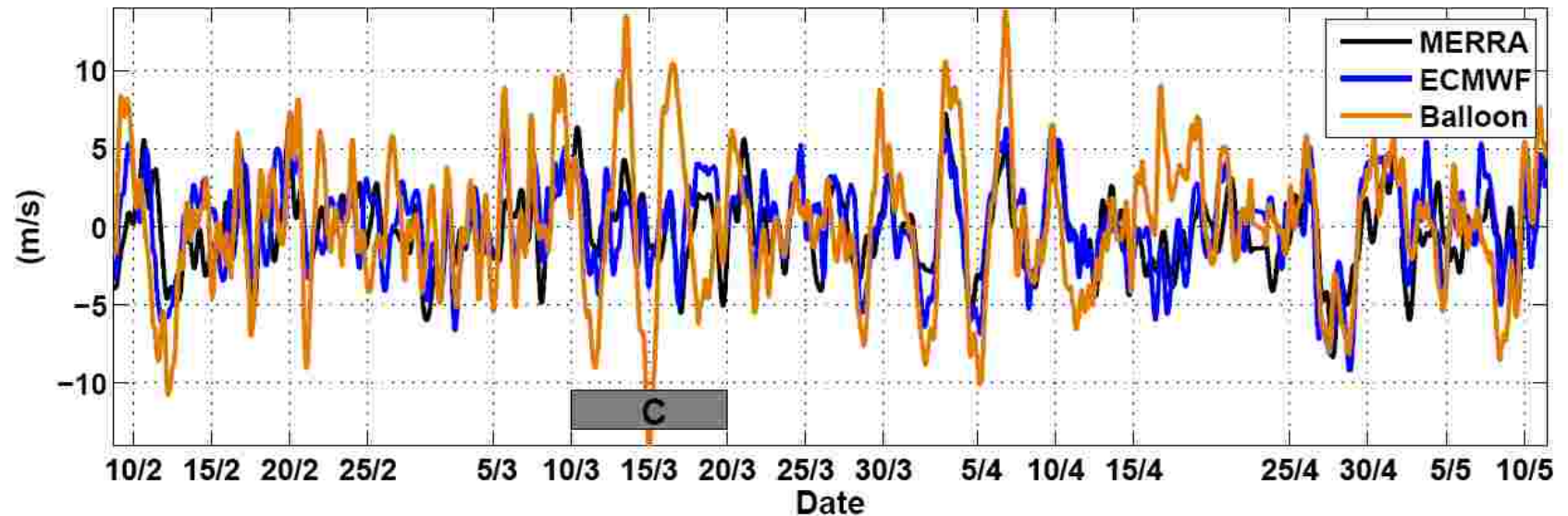


U balloon 2



Time structure of the errors

V balloon 1

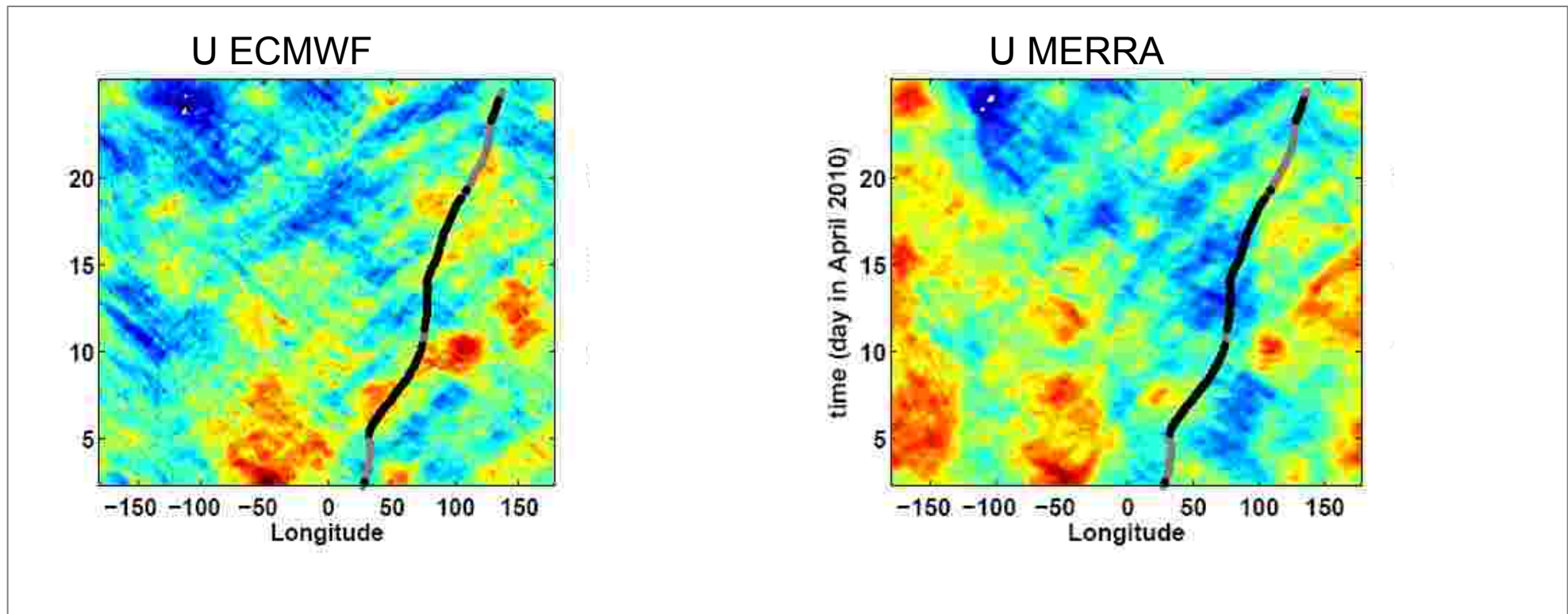


Errors happen during **limited but long-lasting time periods**

Case A

Small errors in ECMWF analyses, large errors in MERRA (> 7 m/s)

→ comparison between the two



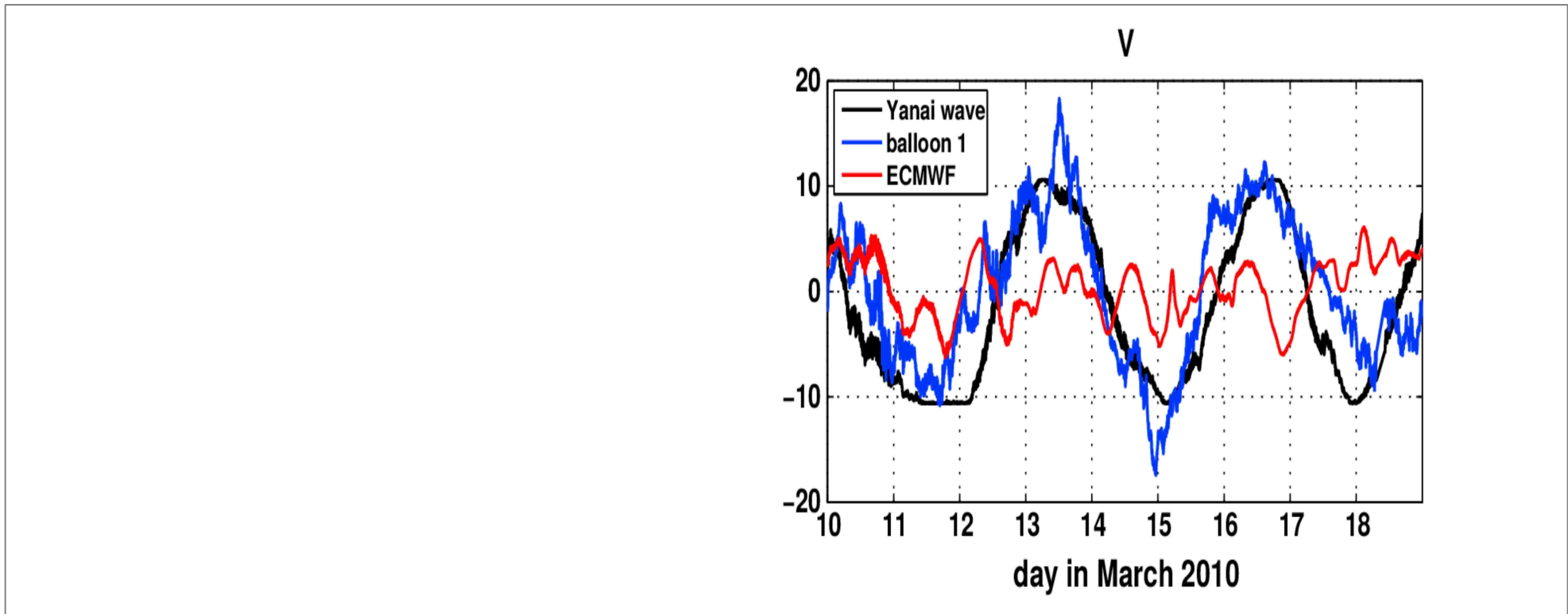
→ Error due to a 'missing' **Kelvin wave**

(not shown : other cases of strong errors on u due to missing Kelvin waves in both MERRA and ECMWF)

Case C

Strong errors in ECMWF and MERRA analyses, with clear meridional wind oscillation

Synthetic Yanai wave time series of u and v

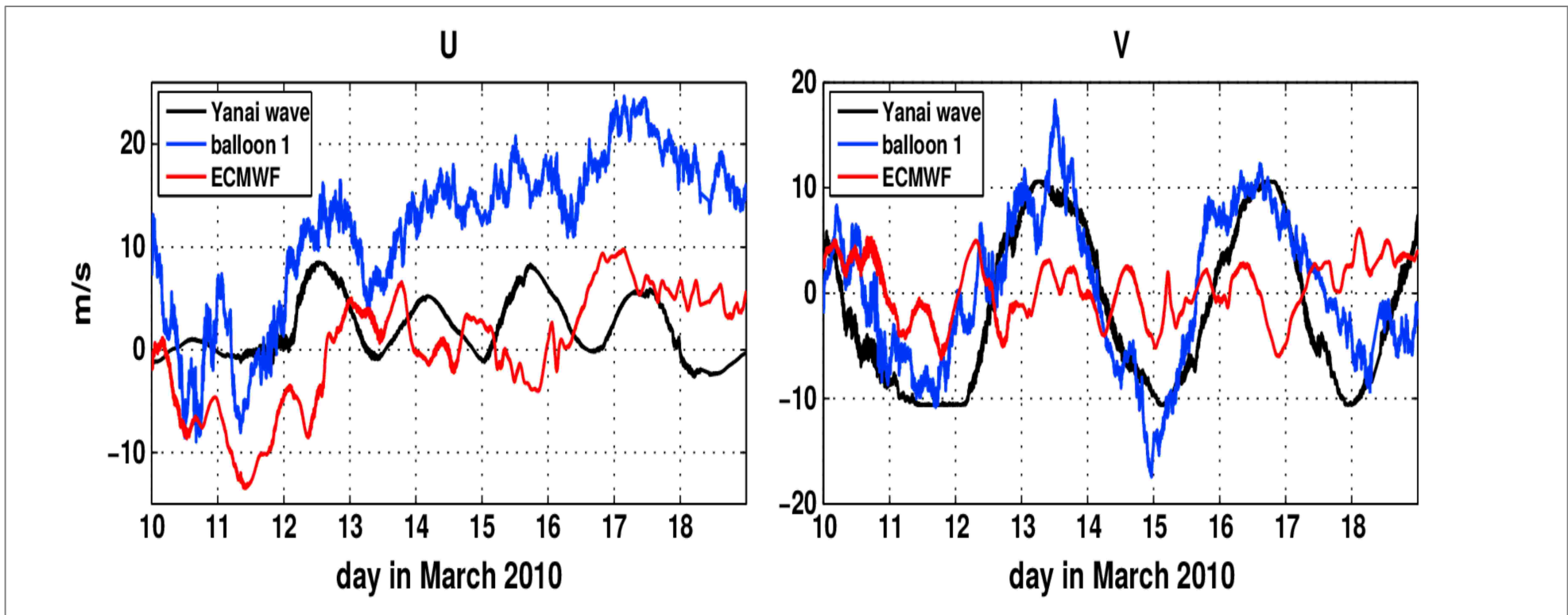


→ Error due to a 'missing' **Yanai wave**

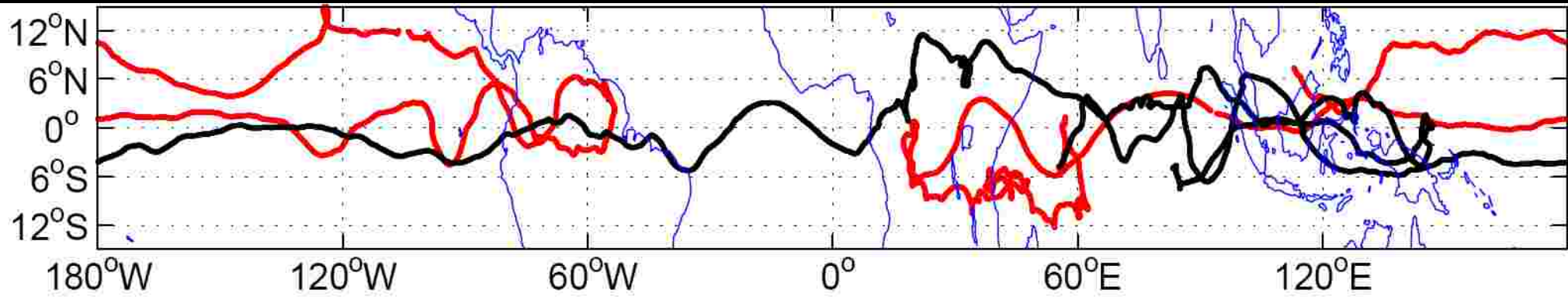
Case C

Strong errors in ECMWF and MERRA analyses, with clear meridional wind oscillation

Synthetic Yanai wave time series of u and v

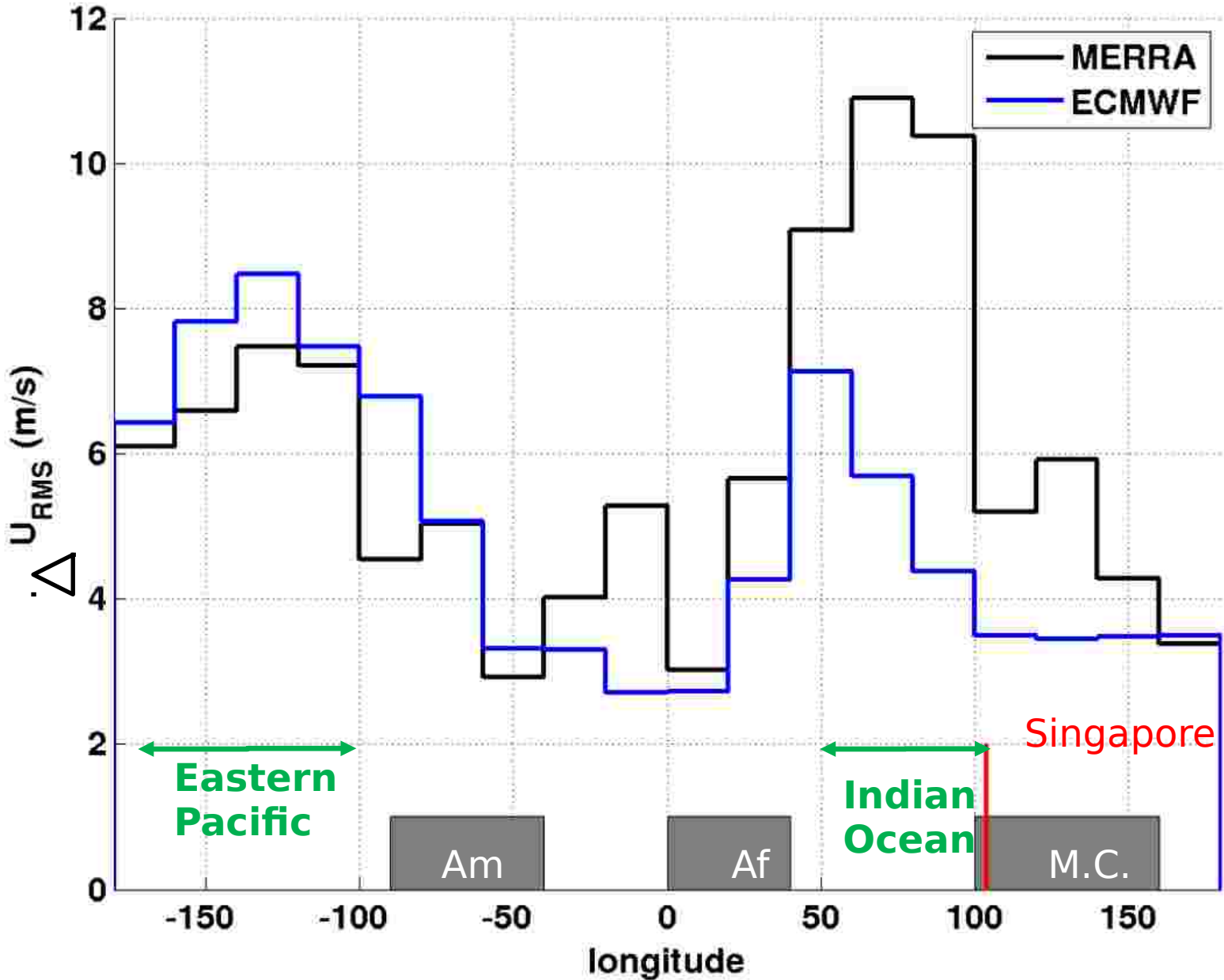


→ Error due to a 'missing' Yanai wave



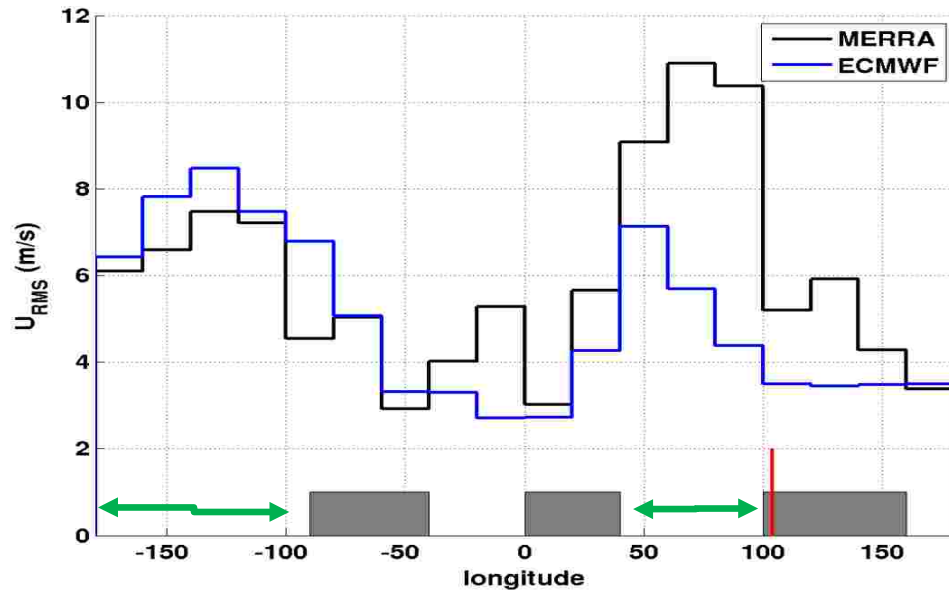
Distribution of wind obs. & errors

Errors twice larger over poorly observed regions



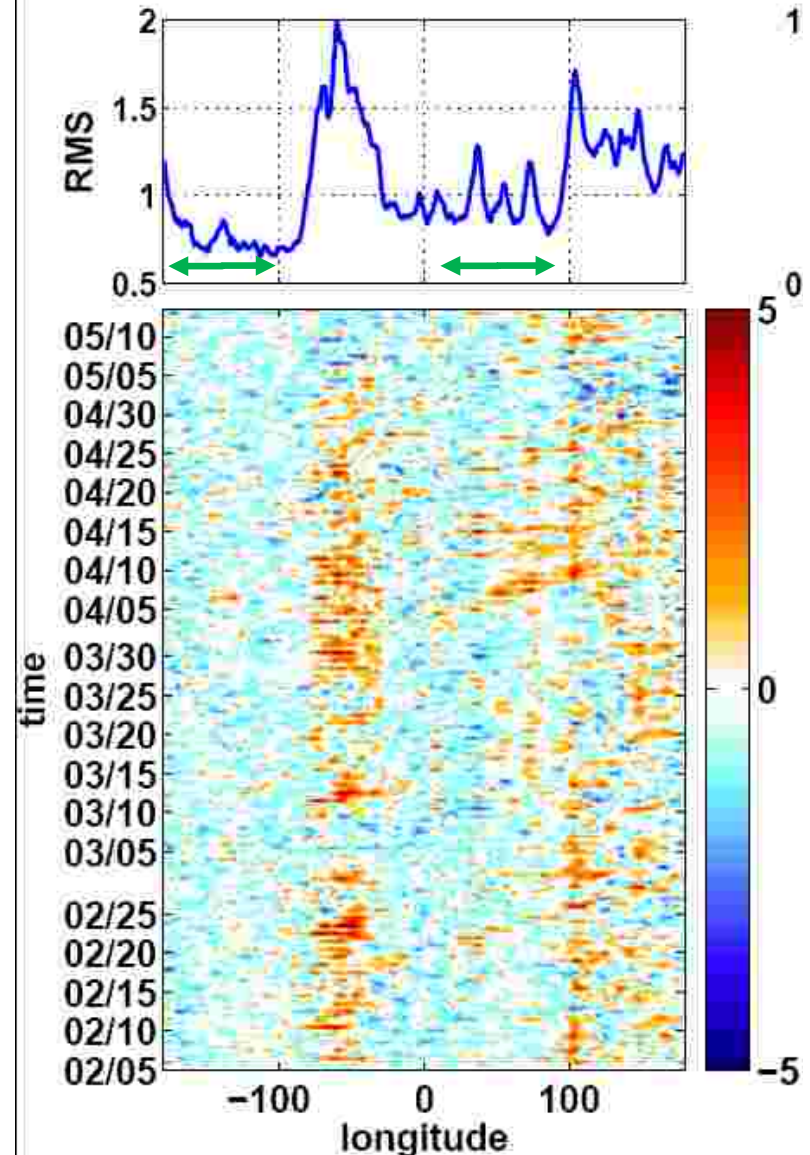
Distribution of wind obs. & errors

Errors during Pre-Concordiasi (~60 hPa)



**Poorly observed regions:
Indian Ocean, Eastern Pacific**

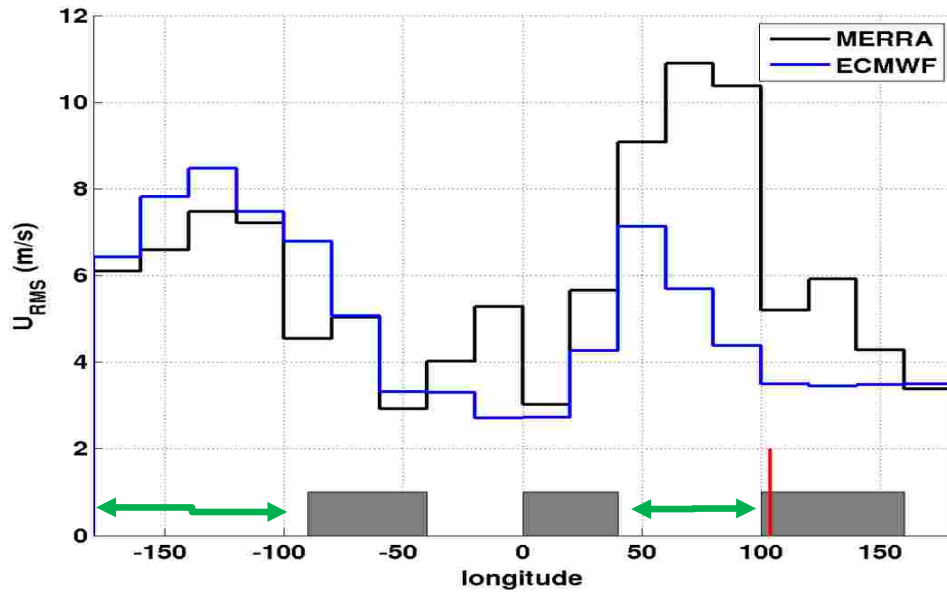
Increments on U



Stronger wind increments over observed regions
→ **Errors and increments simply anticorrelated**

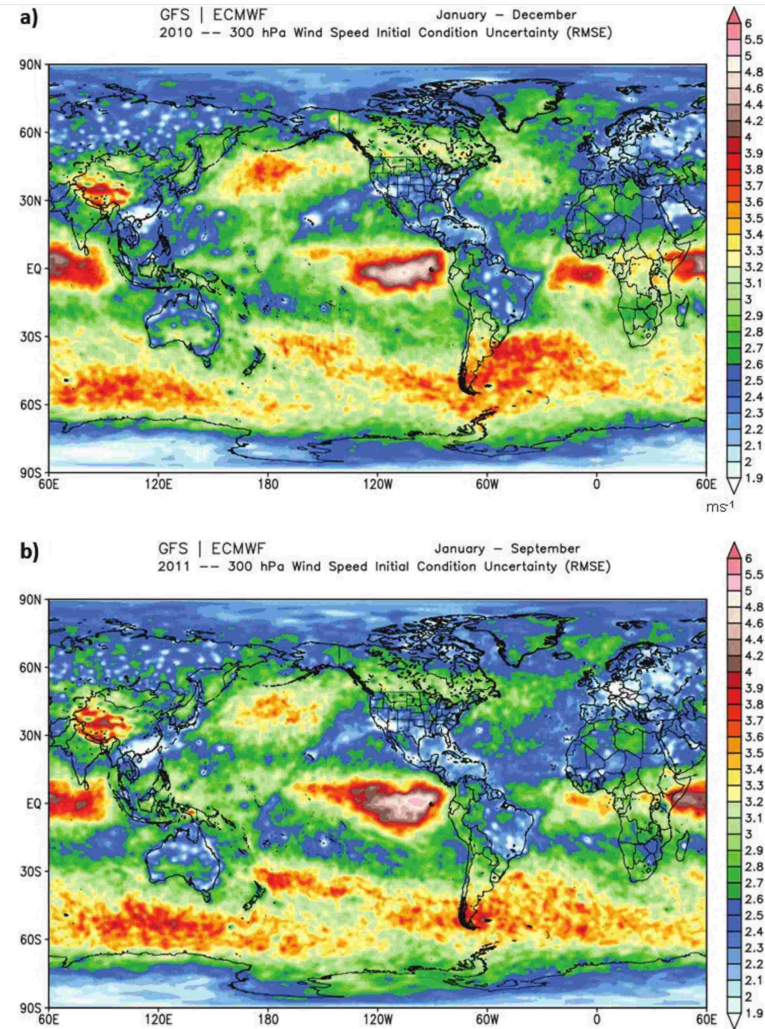
Distribution of wind obs. & errors

Errors during Pre-Concordiasi (~60 hPa)



Poorly observed regions:
Indian Ocean, Eastern Pacific

Differences between GFS and ECMWF, 300hPa, 2010-2011



Baker et al., 2014

Stronger wind increments over observed regions

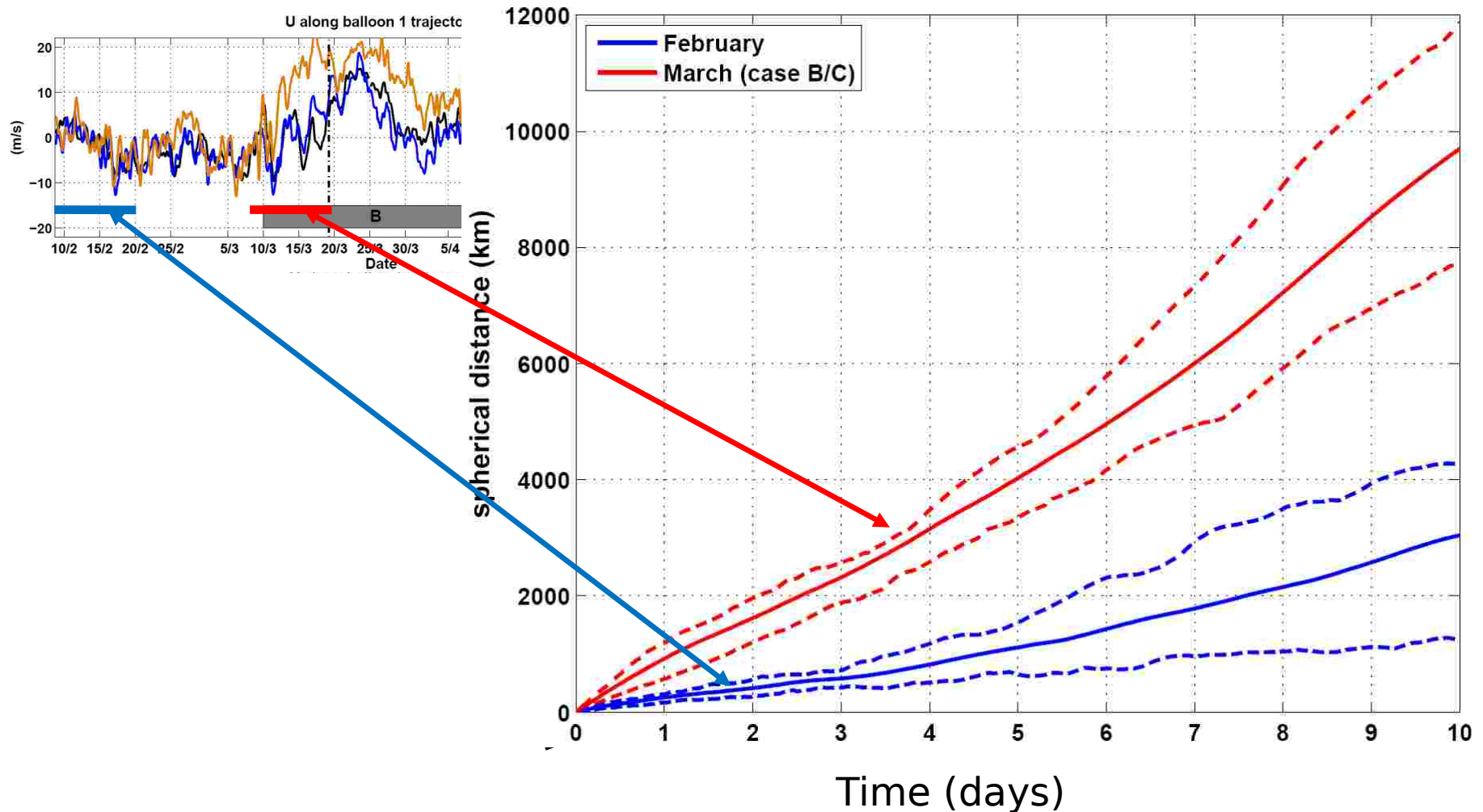
→ **Errors and differences between analyses simply anticorrelated**

Implications

Errors in **trajectory calculations** based on analyzed winds

Important because the estimation of many TTL processes (dehydration, transport) use such trajectory calculations

Errors on balloon positions simulated with analyzed winds



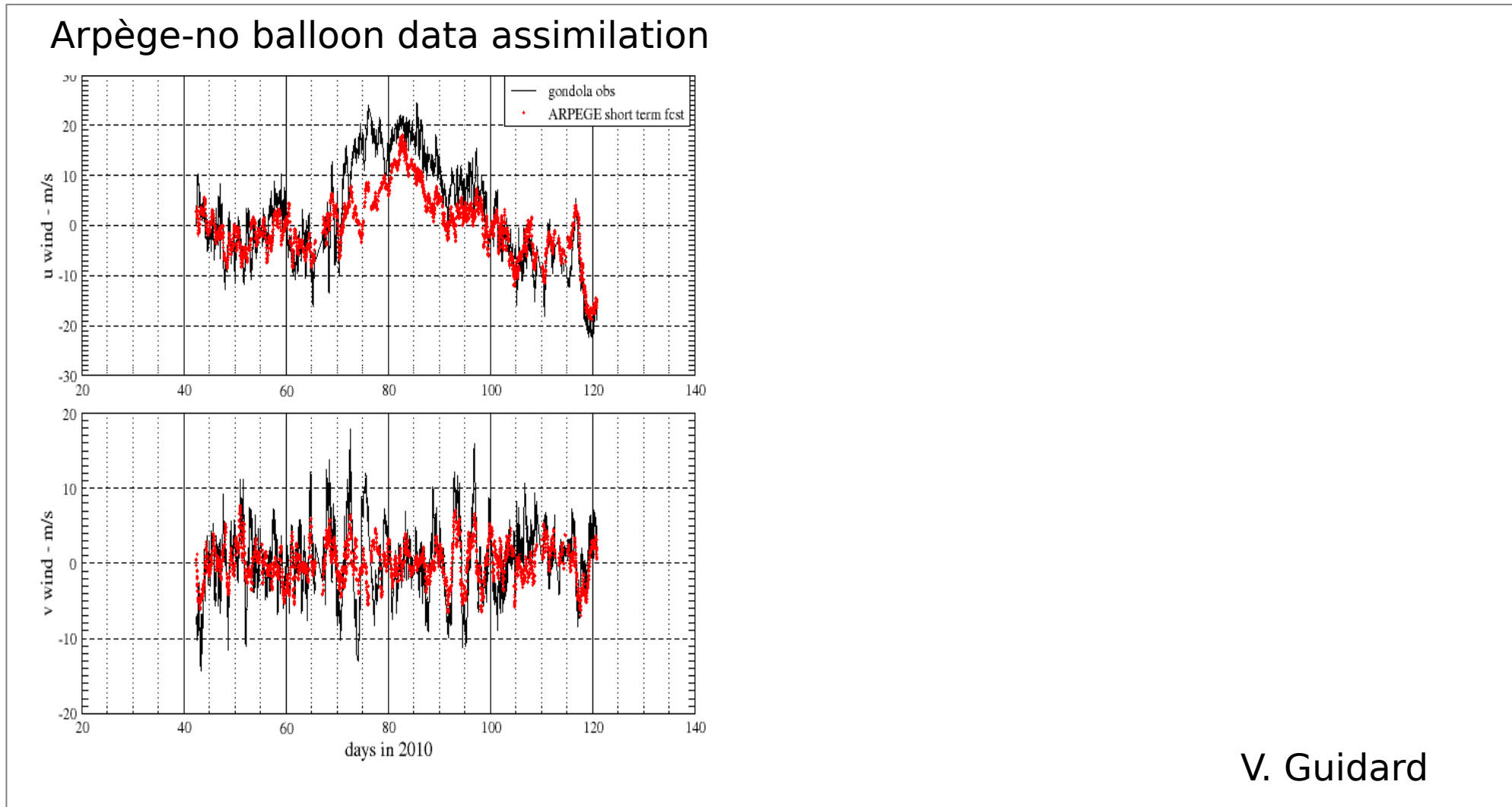
Conclusions

- **Large, long-lasting errors** in the equatorial dynamics in current NWP products
- Mostly due to **poorly simulated equatorial waves**
(Kelvin and Yanai waves)
- Main cause of error is the **lack of wind observations**
- Secondary cause of error : model vertical resolution

Impact of the assimilation of balloon data

Experiment of assimilation of PreConcordiasi balloons in Météo-France NWP system by Vincent Guidard (CNRM)

No balloon data assimilation : comparable to ECMWF

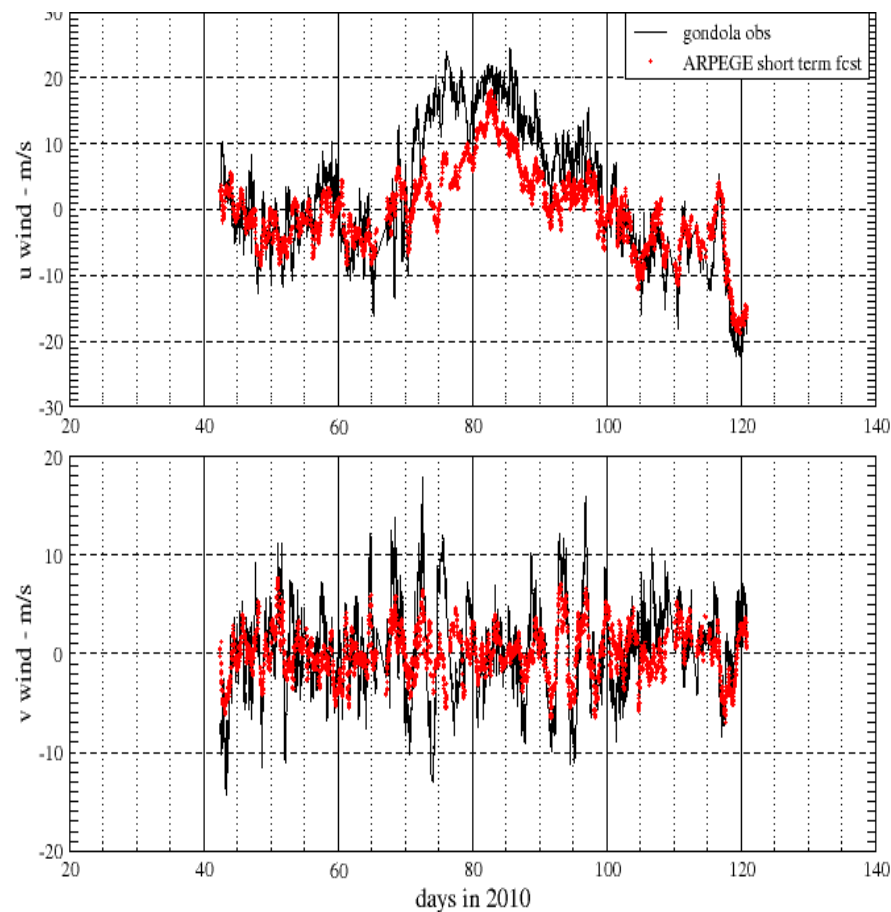


Impact of the assimilation of balloon data

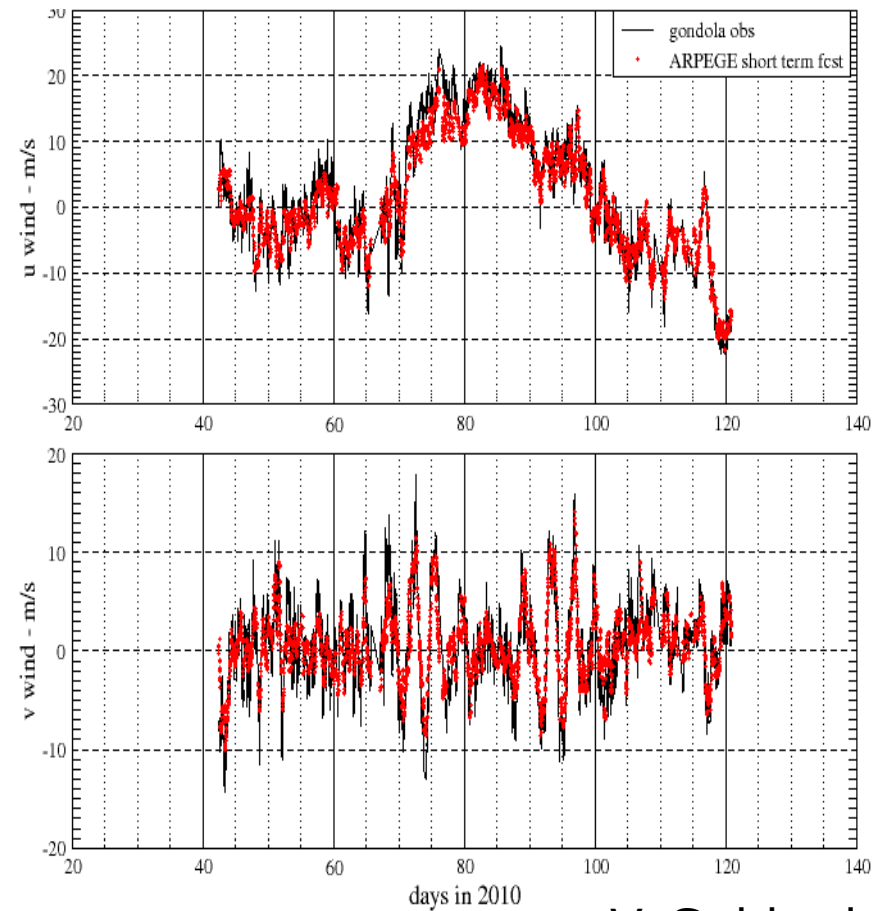
Experiment of assimilation of Pre-Concordiasi balloons in Météo-France NWP system by Vincent Guidard

No balloon data assimilation : comparable to ECMWF
With balloon data assimilation : strong improvement

Arpège-no balloon data assimilation



Arpège-with balloon data assimilation

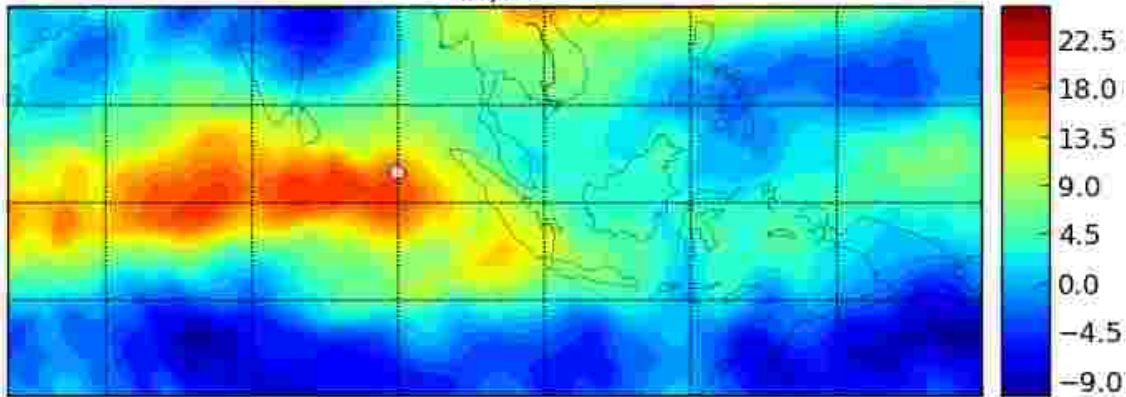


V. Guidard

Impact of the assimilation of balloon data

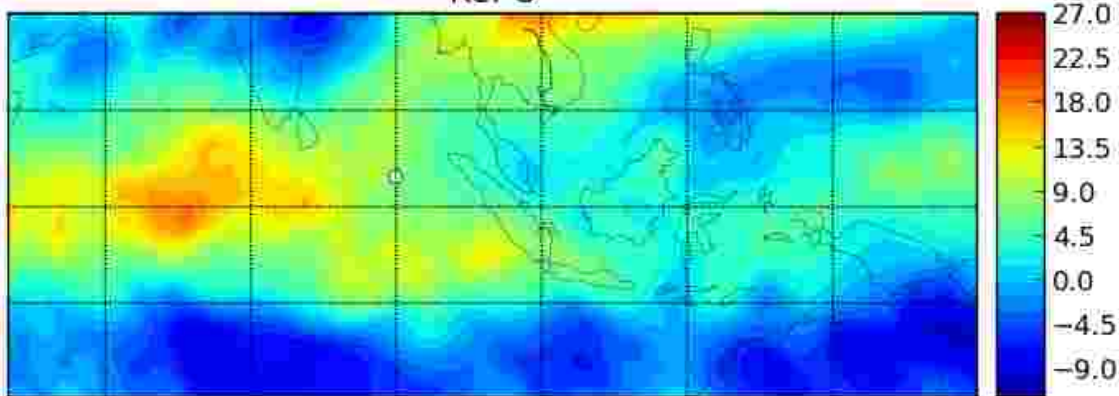
Arpege-with balloon data assimilation

Exp U



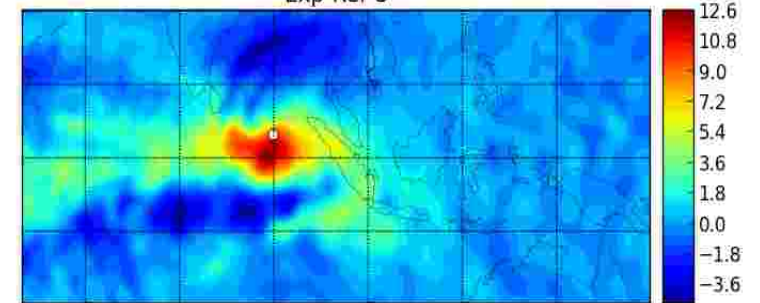
Arpege-no balloon data assimilation

Ref U



Differences

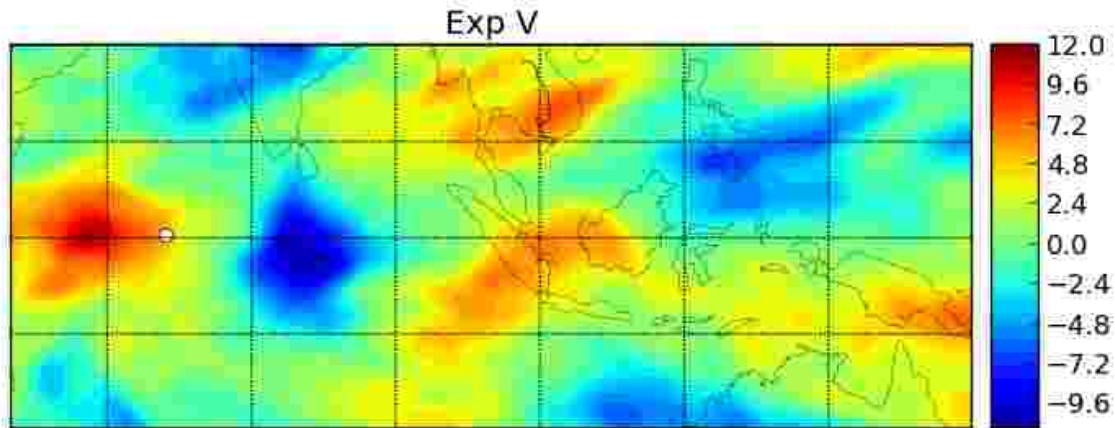
Exp-Ref U



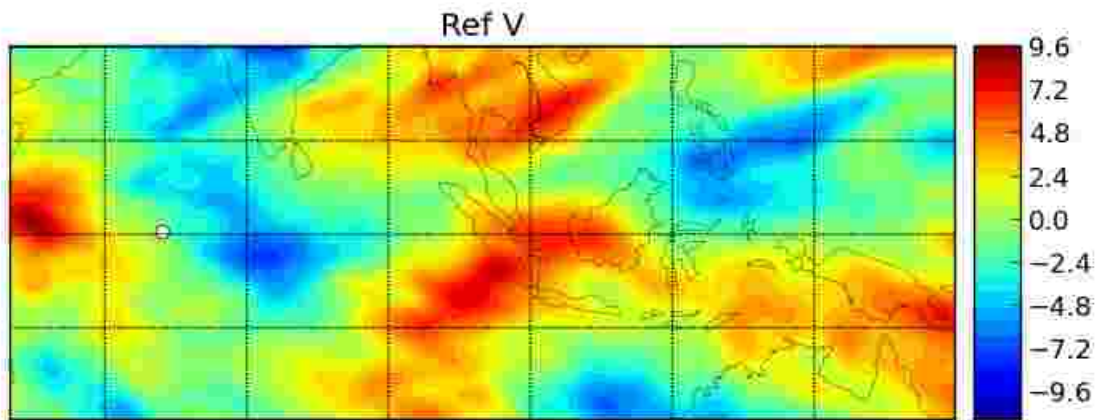
The experiment with balloon data assimilation not only improves u along balloon trajectory but also creates a consistent **Kelvin wave structure**

Impact of the assimilation of balloon data

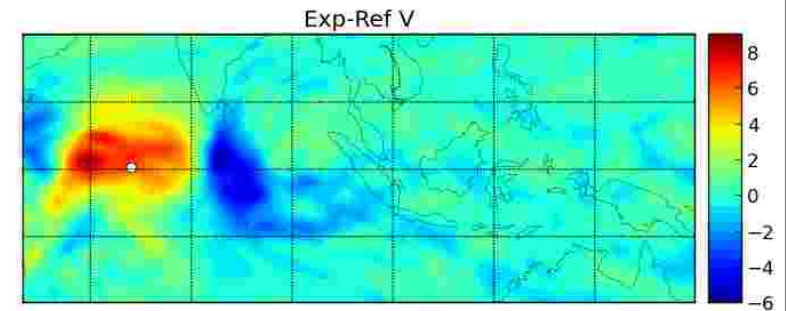
Arpege-with balloon data assimilation



Arpege-no balloon data assimilation



Differences



The experiment with balloon data assimilation not only improves u along balloon trajectory but also creates a consistent **Yanai wave structure**