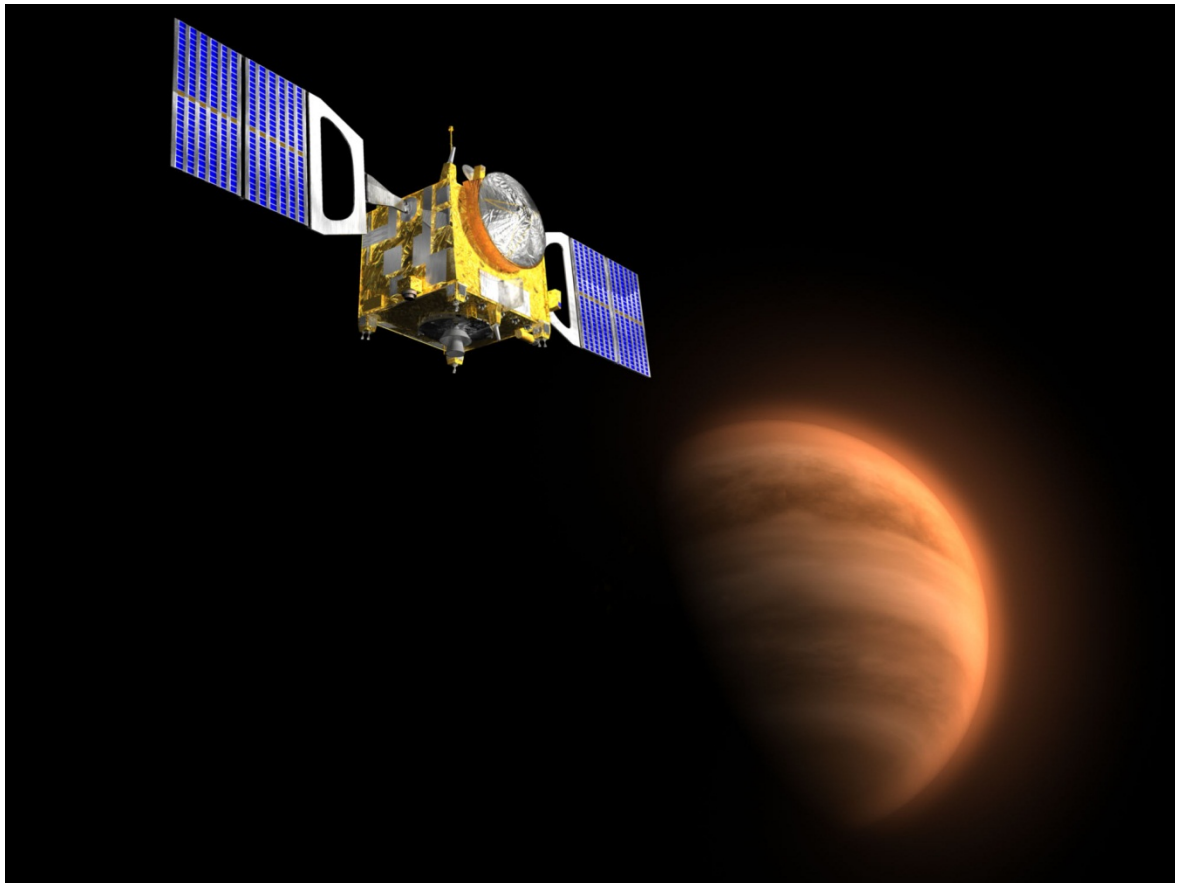
VExADE - Venus Express Atmospheric Drag Experiment



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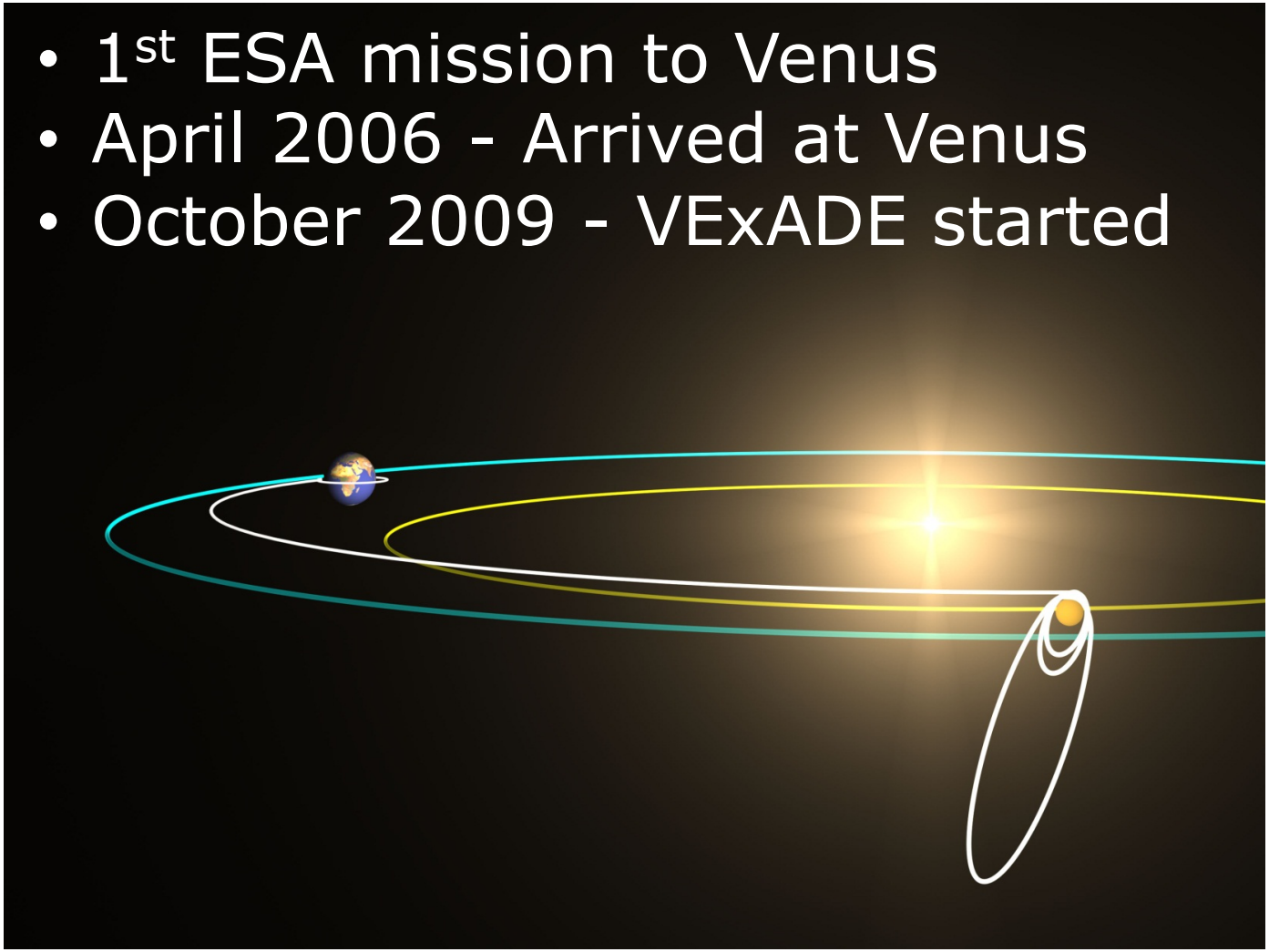
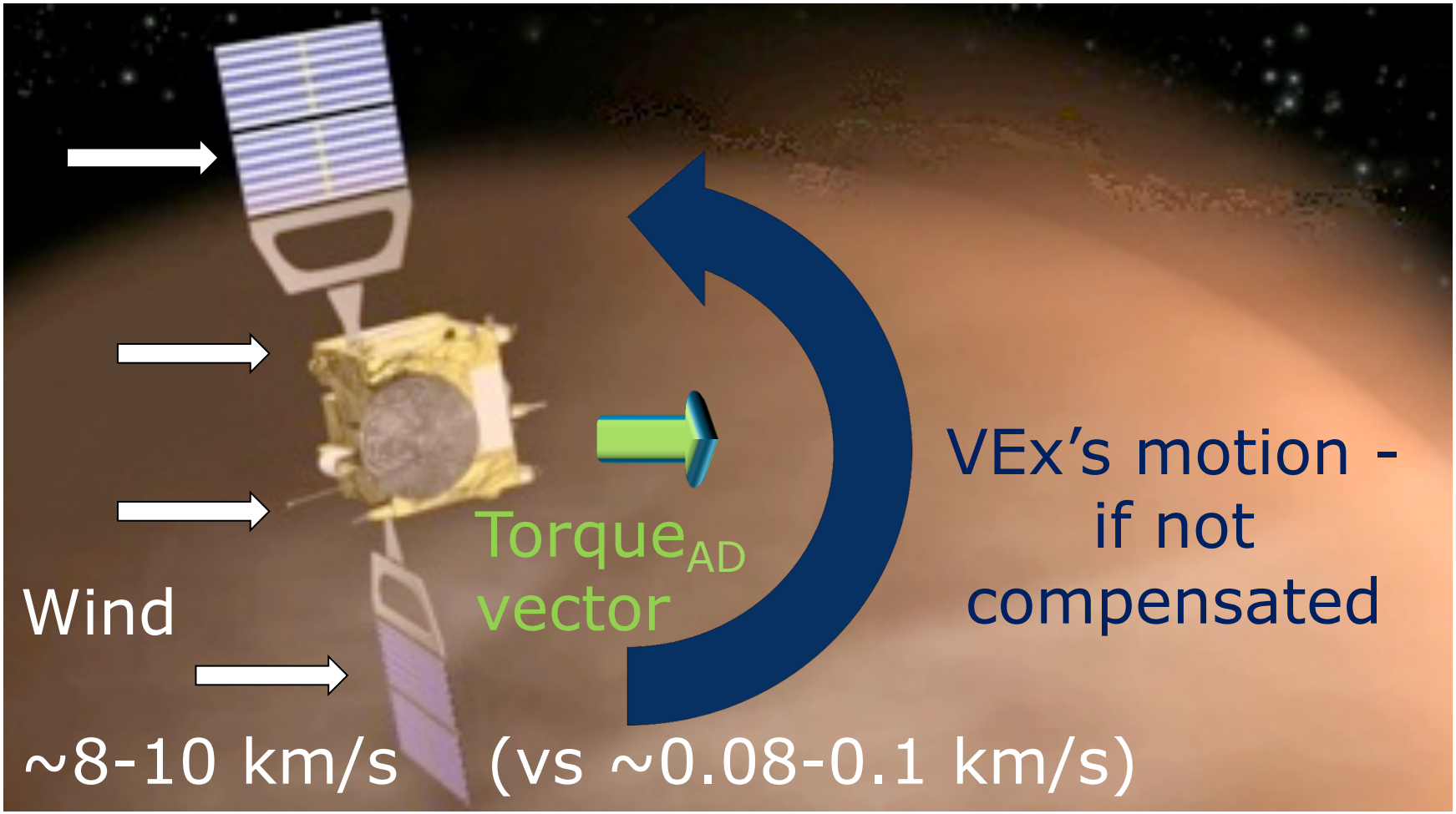
19 November 2013

Venus Express Mission Facts

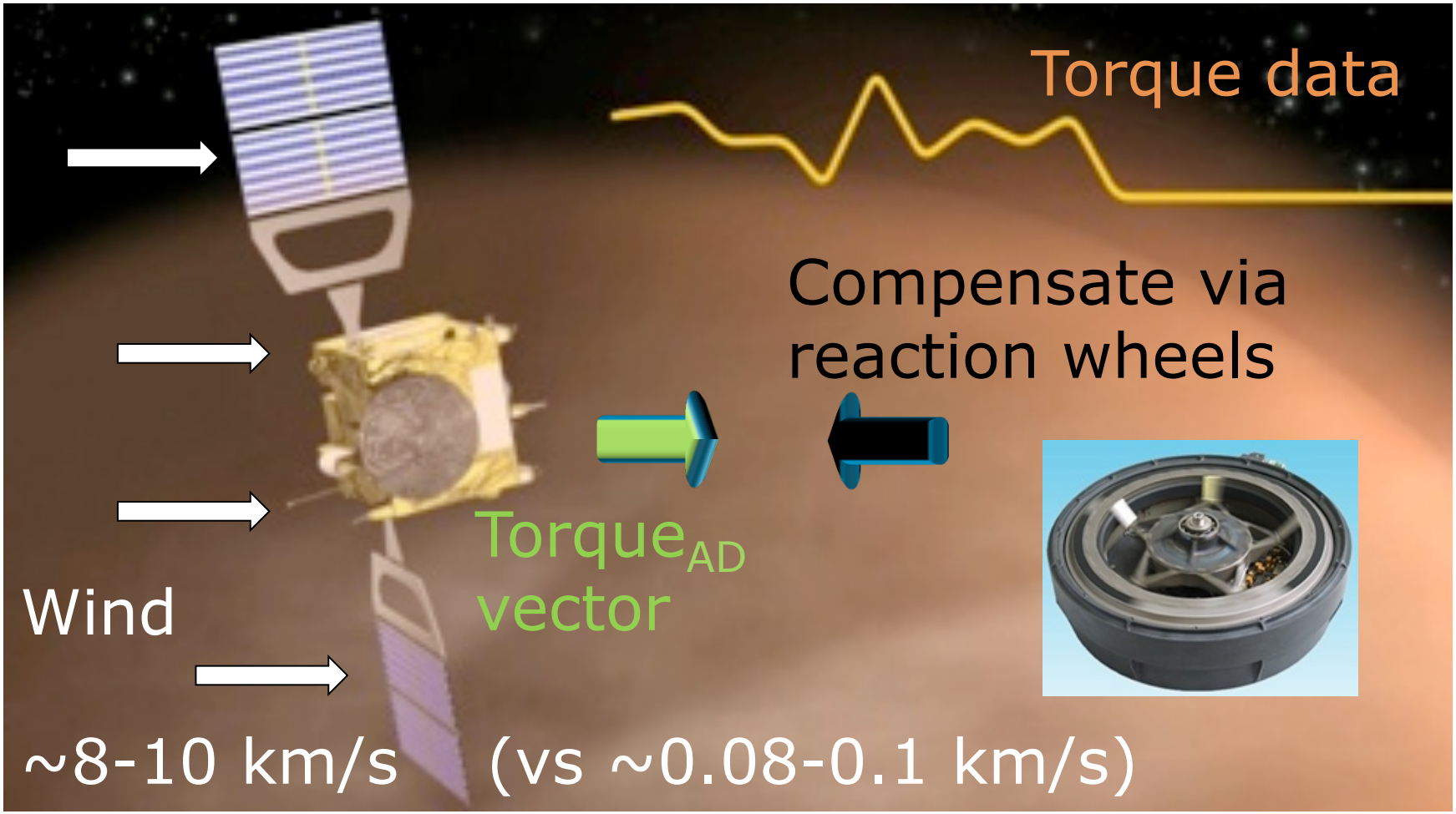
- 1st ESA mission to Venus
- April 2006 - Arrived at Venus
- October 2009 - VExADE started



Atmospheric Drag - 1



Atmospheric Drag - 2



VExADE Data Streams

ADE (8 Hz)

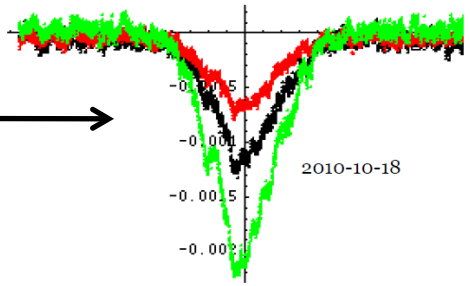
Housekeeping (0,25 Hz)

ESOC Flight Dynamics

ESAC SPICE

MATLAB program

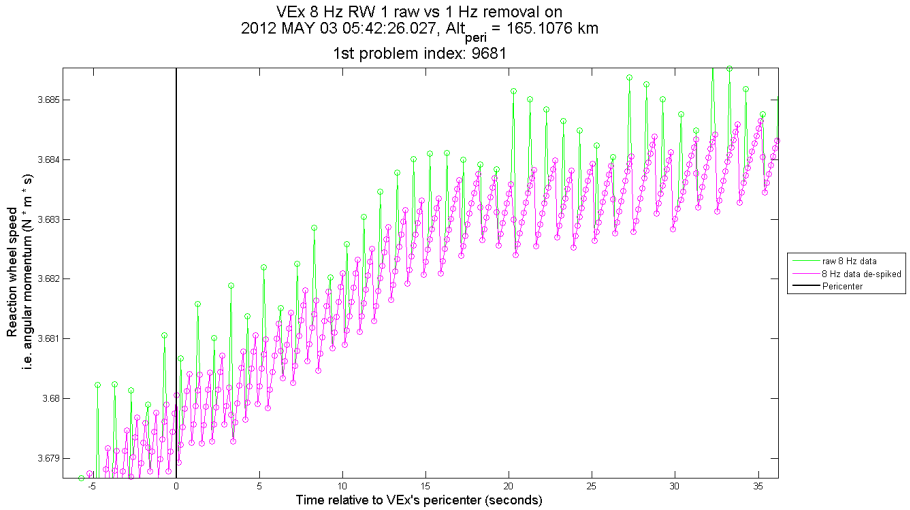
Results



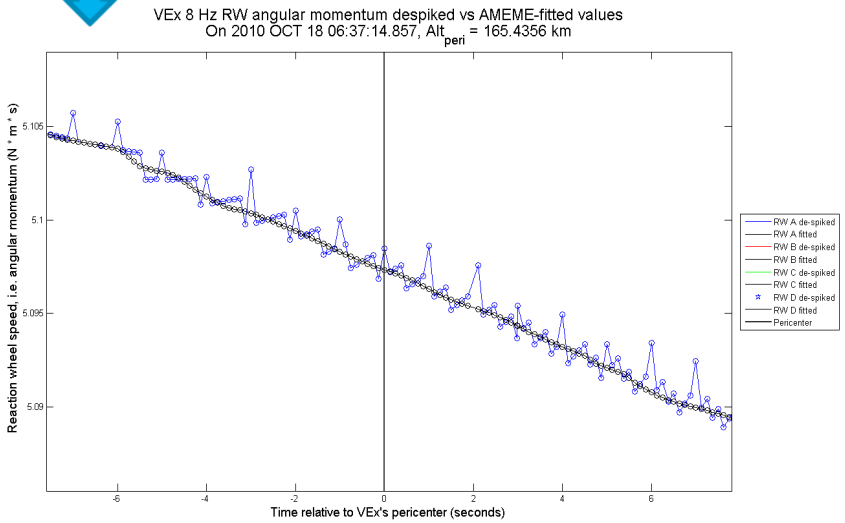
SPICE = Spacecraft, Planets, Instruments, C-matrix, Events

Noise in VExADE Data

1. Systematic error ⇒



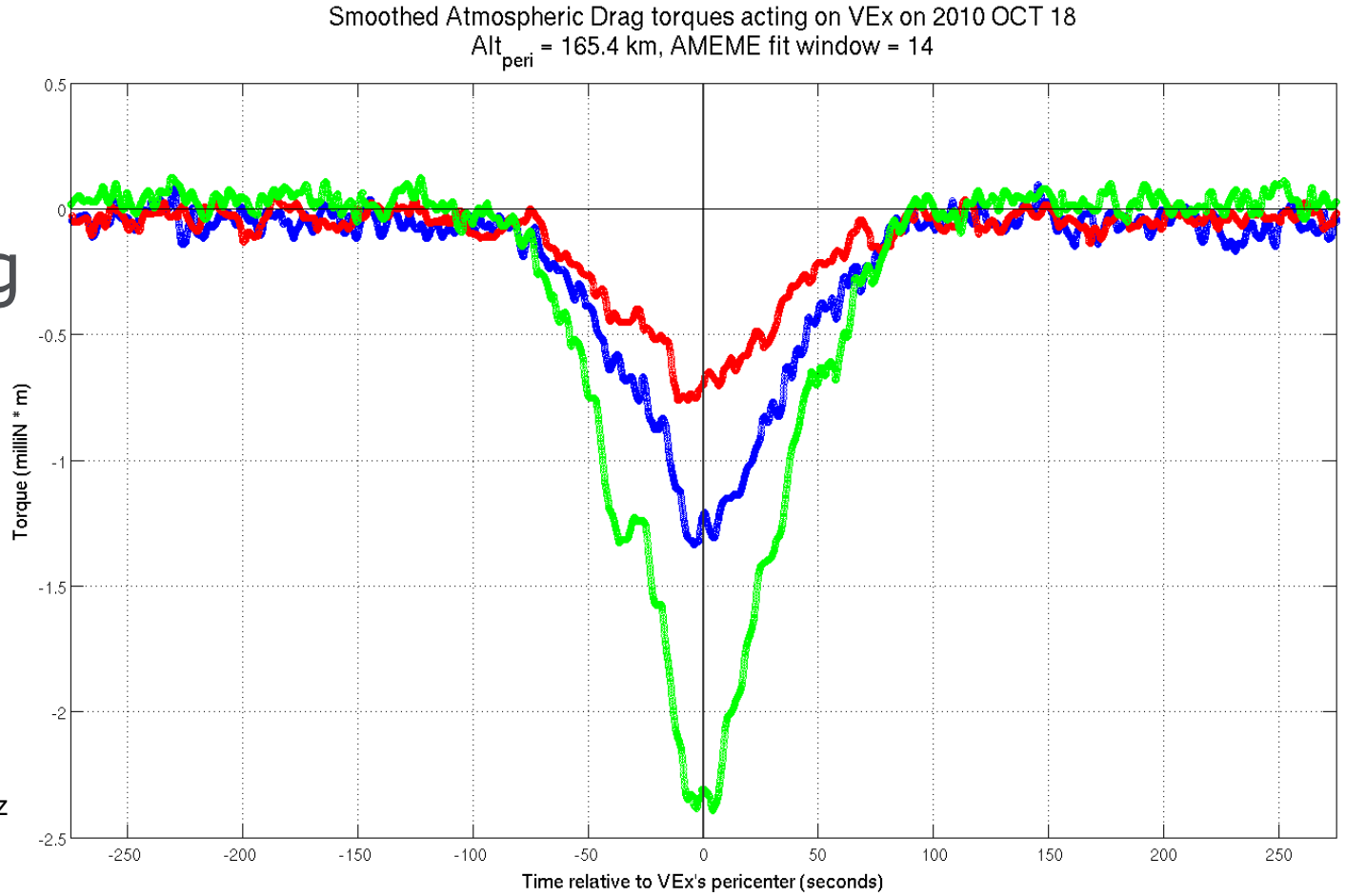
2. Random error ⇓



AMEME – Average of Maximum Envelope and Minimum Envelope

VExADE Results - 1

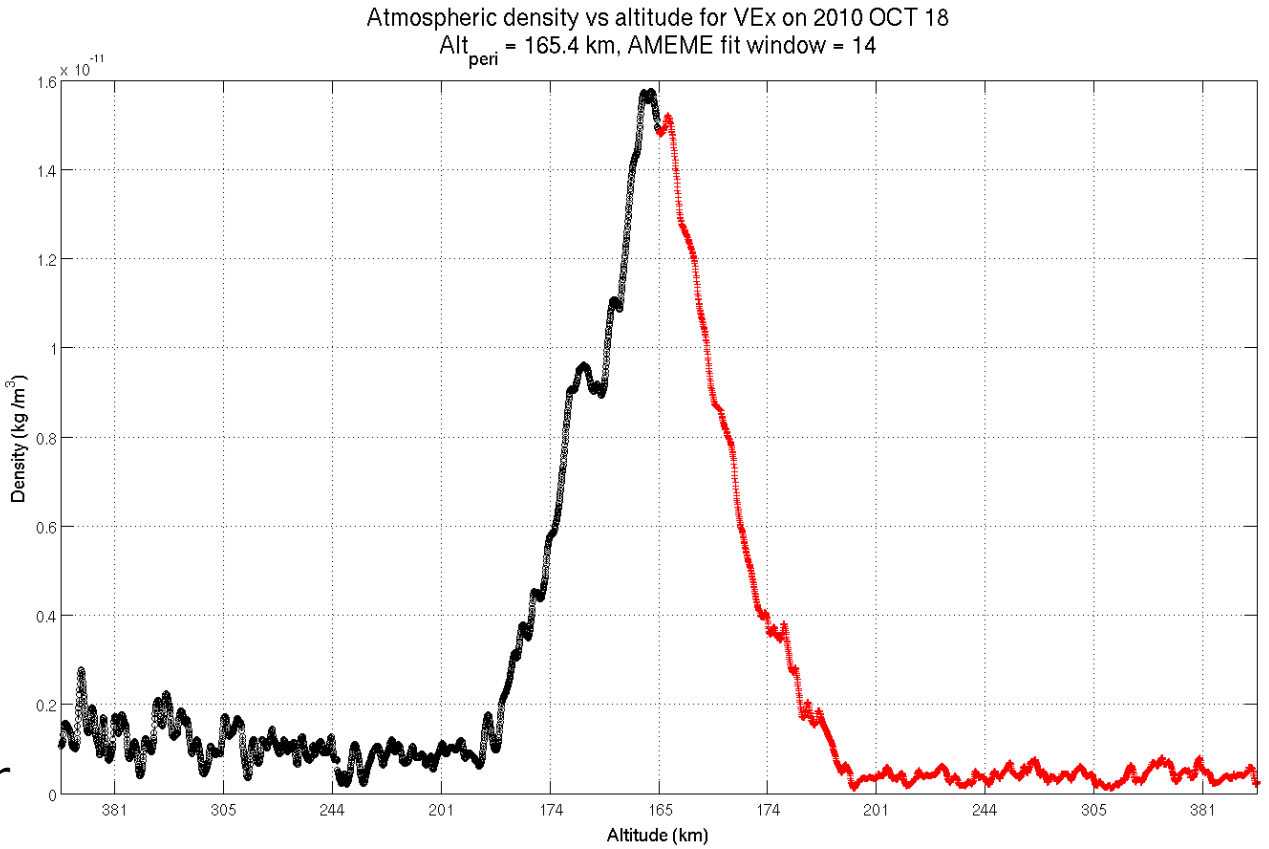
Torque due to Aerodrag



Legend
Blue – Torque$_x$
Red – Torque$_y$
Green – Torque$_z$

VExADE Results - 2

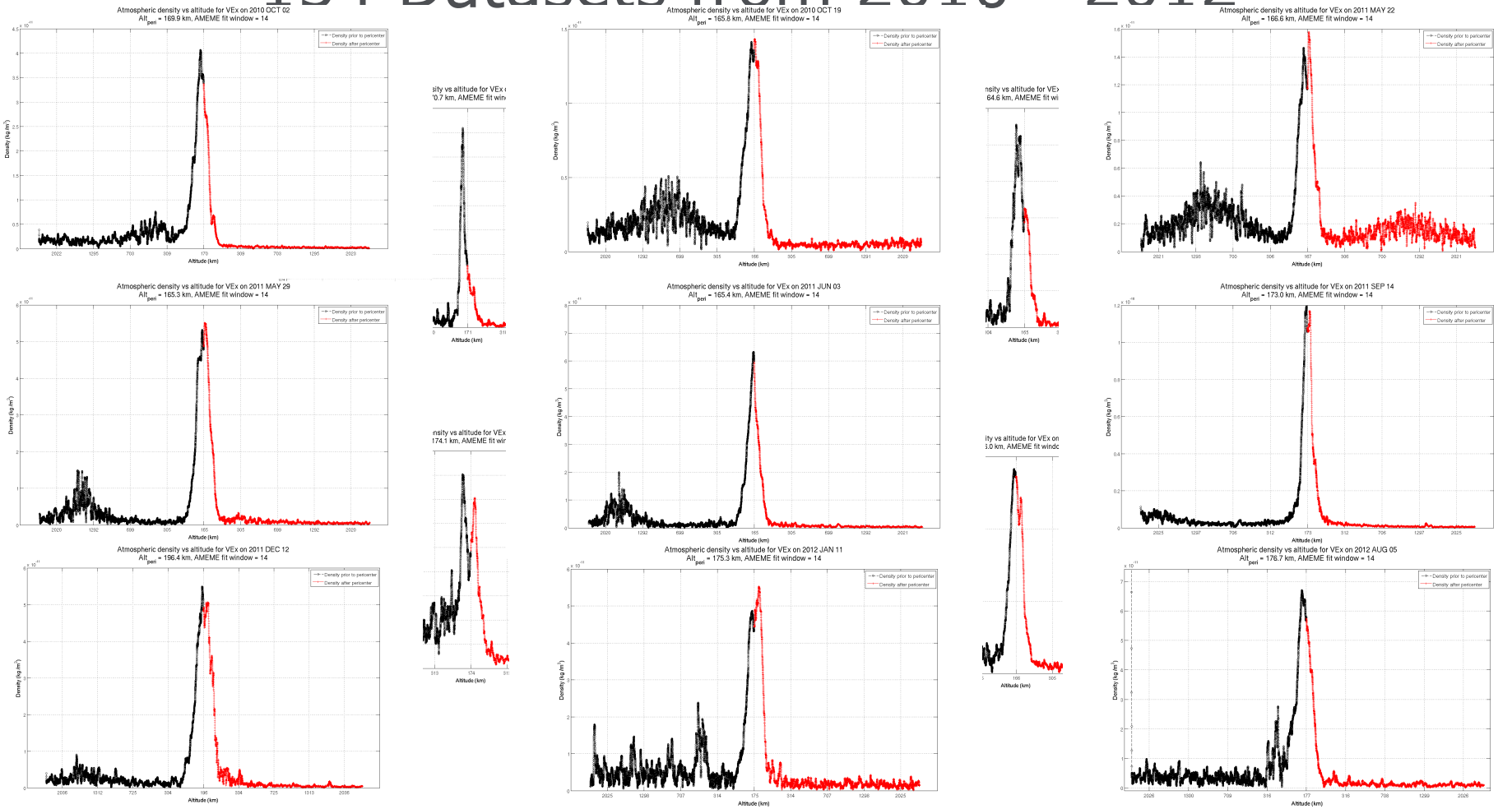
Density (~10^{-12} to 10^{-10} kg /m^3) – with wave signatures?



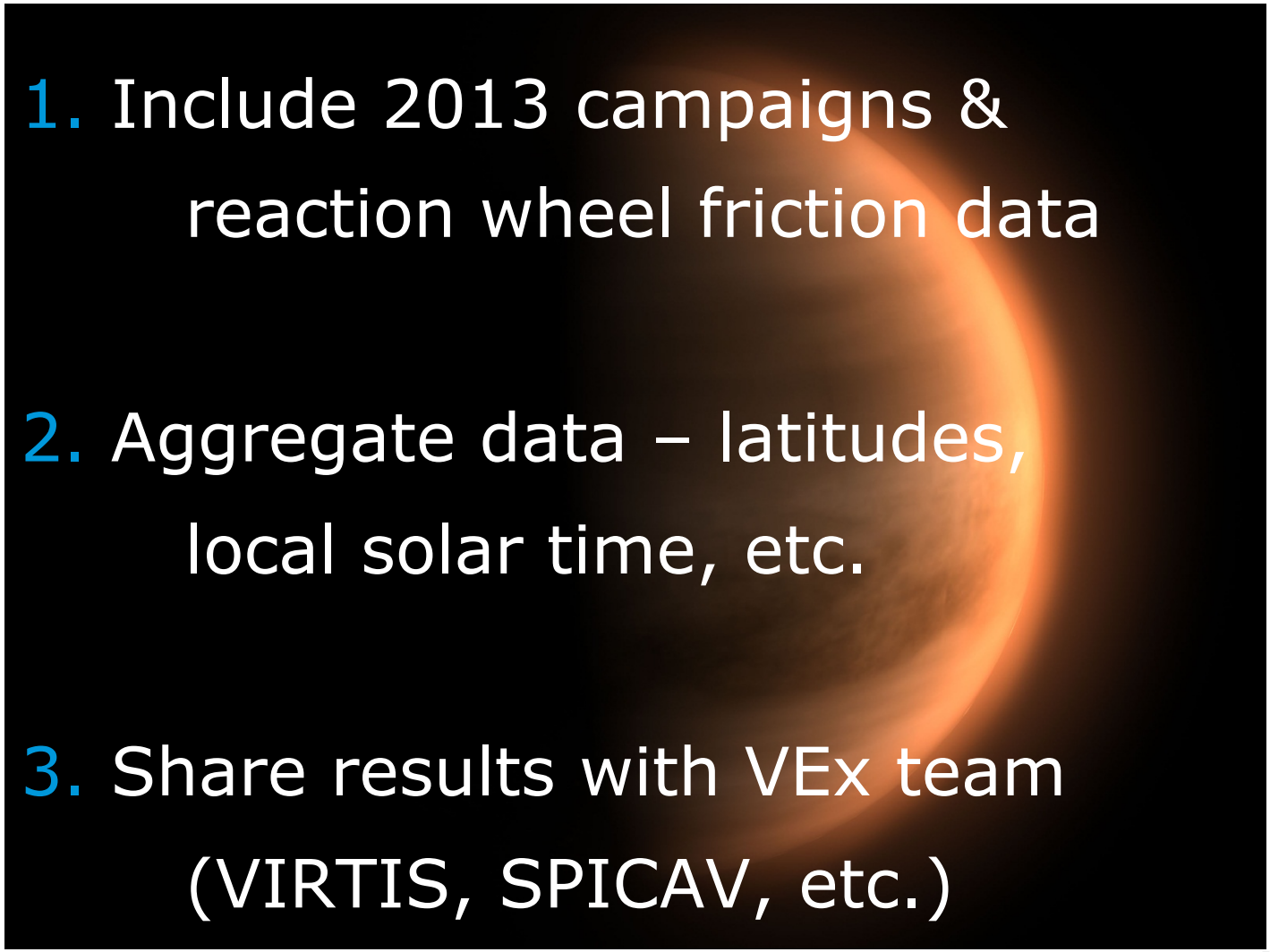
Legend
Black – Pre-pericenter
Red – Post-pericenter

VExADE Results (aplenty) - 3

134 Datasets from 2010 - 2012



Next Steps



1. Include 2013 campaigns & reaction wheel friction data

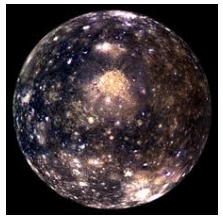
2. Aggregate data – latitudes, local solar time, etc.

3. Share results with VEx team (VIRTIS, SPICAV, etc.)

Research Interests

1. HEMO simulations (PhD in Physics); see
   E.B. Grotheer & S.A. Livi. "Small meteoroids' major contribution to Mercury's exosphere." *Icarus* ***227****.1 (2014)*: 1-7.
2. Expand HEMO with more processes
3. Apply HEMO to other bodies/moons (Luna, Europa, Ganymede, Callisto, …)



Questions?

Fragen? (AT, BE, CH, DE, LU)

Vragen? (BE, NL)

Otázky? (CZ)

Spørgsmål? (DK)

Kysymykset? (FI)

Des questions? (BE, CH, FR, LU)

Ερωτήσεις? (GR)

Ceisteanna? (IE)

Questiones? (CH, IT)

Spørsmål? (NO)

Pytania? (PL)

Perguntas? (PT)

Întrebări? (RO)

Preguntas? (ES)

Frågor? (SE)

Questions? (GB, CA)

Kérdések? (HU)

Küsimused? (EE)

Vprašanja? (SI)

Jautājumi? (LV)

Backup Slide: VExADE equations

$$\vec{T}_{env} = I_{com,SC}\dot{\vec{\omega}} + \vec{T}_{RW} + \vec{\omega} \times \vec{L}_{SC}$$

$$\vec{T}_{GG} = \frac{3\mu}{r^5}\vec{r} \times I_{COM,SC}\vec{r}$$

$$\vec{T}_{AD} = \vec{T}_{env} - \vec{T}_{GG}$$

A_{SA} = solar array panel area

V = wind velocity

$n_{\pm}$ = solar array normals

e_w = wind direction

$r_{SA\pm}$ = solar array centers of pressure

a = accomodation coefficient (0.9)

T_{env} = environmental torque

$I_{com,SC}$ = VEx inertia tensor

$\dot{\omega}$ = angular acceleration

T_{RW} = torque on reaction wheels

ω = angular rate

L_{SC} = VEx angular momentum

T_{GG} = gravity gradient torque

μ = mass * grav. constant

r = VEx position

T_{AD} = atmospheric drag torque

ρ = atmospheric density

$$\vec{T}_{AD} = -\rho A_{SA} V^2 \sum \left|\vec{n}_{\pm} \cdot \vec{e}_W\right| \vec{r}_{SA\pm} \times \left(a\vec{e}_W + 2(1-a)(\vec{n}_{\pm} \cdot \vec{e}_W)\vec{n}_{\pm}\right)$$