A New Grid for Global Forecast System Model

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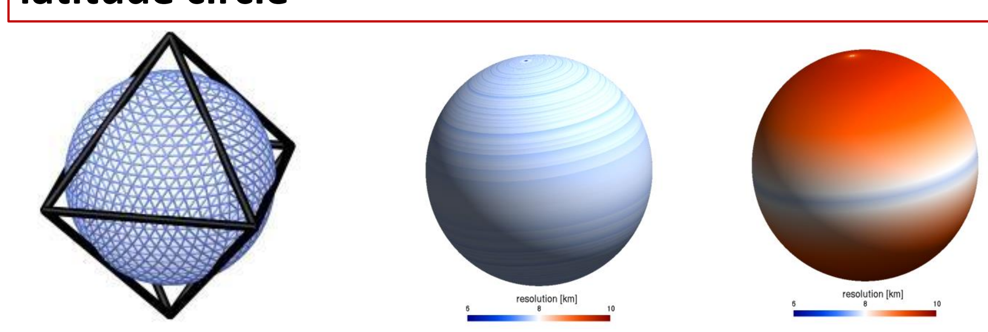
Relationship between spectral truncation and grid point resolution

- **Linear grid (used in original version):** The shortest wavelength is represented by 2 grid points → $4N \simeq 2(T_L + 1)$
- **Quadratic grid:** The shortest wavelength is represented by 3 grid points → $4N \simeq 3(T_Q + 1)$
- **Cubic grid (implemented):** The shortest wavelength is represented by 4 grid points → $4N \simeq 4(T_C + 1)$

Triangular Cubic Octahedral Grid (Collignon Projection of Sphere on Tetrahedron)

Generation of Octahedral grid follows an arithmetic progression for assigning number of longitude points at each latitude circle $N_i = 4*i + 16$; i represents the i th latitude circle



Courtesy : ECMWF

Comparison of the zonal variation in resolution for the N1280 original reduced Gaussian grid (left) with the corresponding O1280 octahedral grid (right) on the surface of the sphere

Advantages of TCO grid and its implementation

- Improved representation of orography
- Global mass conservation improves
- Computationally more efficient
- Local derivative calculation is more accurate
- Works well with scale aware physics
- Negative tracers are reduced considerably

Implementation of TCO in GFS V13 and V14

- Spectral Initial Condition files remapped onto the new truncation corresponding to TCO grid.
- Surface initial conditions and the fix files are regridded to the Octahedral reduced Gaussian grid from the conventional reduced Gaussian grid.
- Tuning of diffusion coefficient to reduce noise

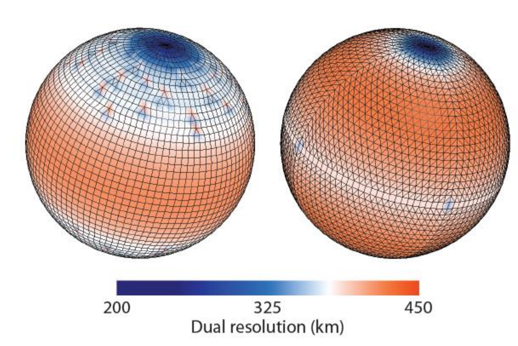
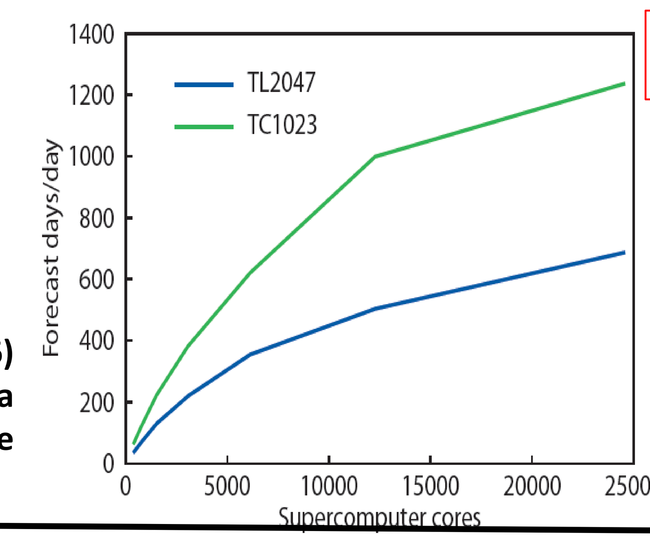


Figure (adopted from ECMWF News Letter 146) demonstrates that the octahedral mesh (right) has a locally more uniform dual-mesh resolution than the reduced Gaussian mesh (left).



Advantage of Tco765 vs T1534

3074 x 1536 (GFS T1534) x 64L : 3088 x 1536 (GFS Tco 765) x 64L

1)Same Spatial resolution at half of the Spectral resolution
2)Gibbs phenomenon is reduced in Tco 765 at all lead times
3)Decrease in the Dynamics computation

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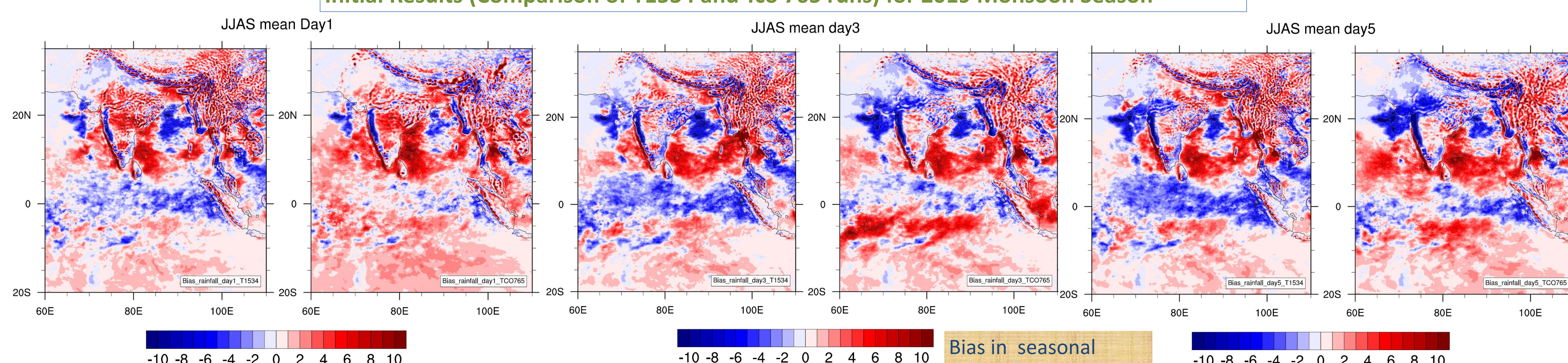
An estimate of time taken by individual modules in GFS T1543 and Tco765

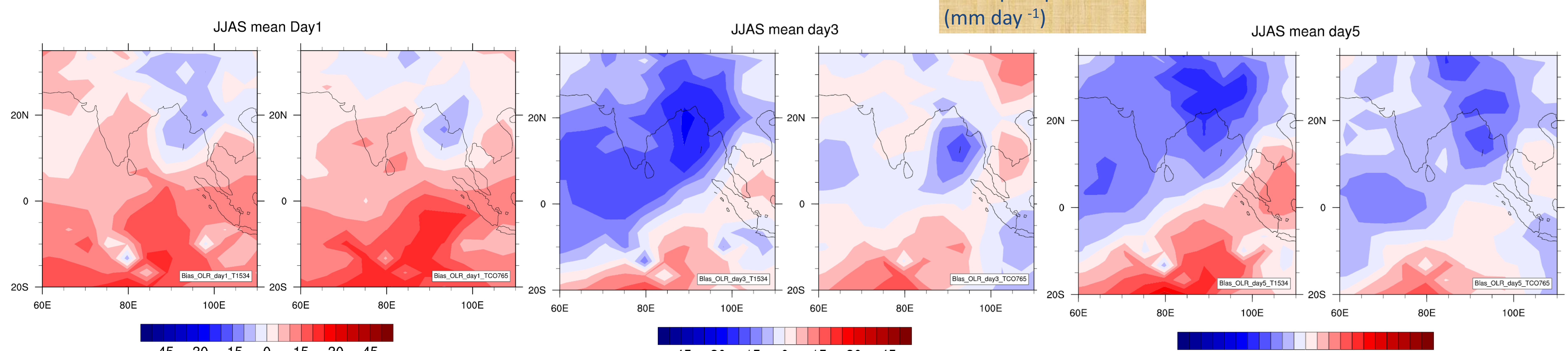
Ongoing work on High Resolution GFS Tco (~5KM)

Porting of GFS Tco1534 on Pratyush
Forcing files created for the Tco1534

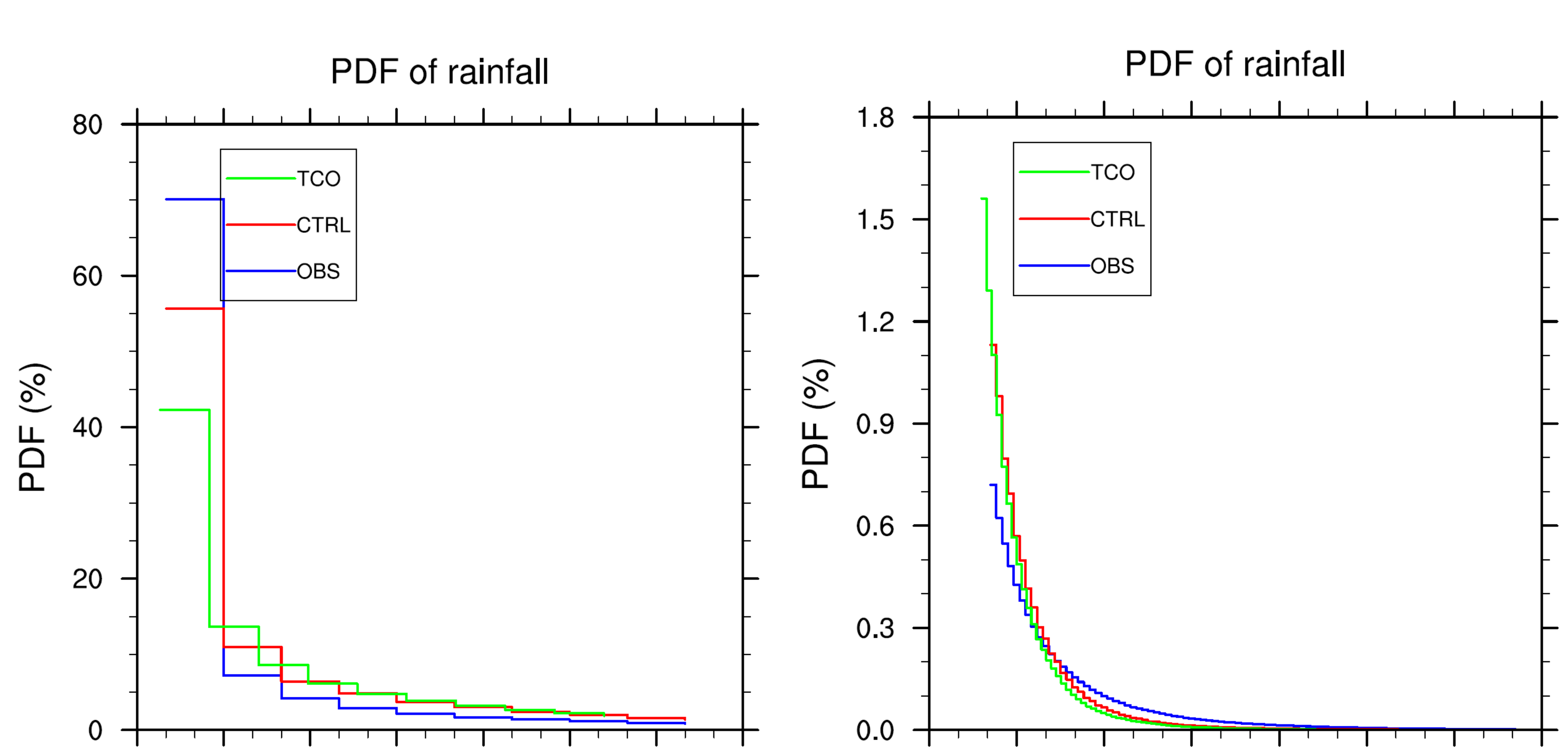
Initial Results (Comparison of T1534 and Tco 765 runs) for 2019 Monsoon Season



Bias in seasonal mean precipitation (mm day $^{-1}$)



Bias in seasonal mean OLR (W m^{-2})



Probability Density Function of rainfall over south-Asian monsoon region (Distribution's tail is zoomed in right panel)

Future Plans for model development

1. Implementation of Tco grid in a low resolution model for model fidieity.
2. Tuning the model parameters and checking the sensitivity of diffusion coefficients
3. Performing hindcast runs for model Validation
4. Implementation and tuning the model with
   1. ISRO satellite derived Land–Use Land –Cover (LULC)
   2. Surface albedo of MODIS
   3. Surface emissivity of CAMEL
   4. Stochastically Perturbed Parameterization Tendency (SPPT)
5. Testing of Ensemble Model with Tco grid at higher resolution version (Tco 1534) with SPPT
6. Coupling of GFS T1534 /Tco 765 with Ocean model (MoM/NEMO)

Acknowledgements

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